Abstract

Esthetic dentistry encompasses those procedures designed to enhance and improve form and appearance of the maxillofacial region. Esthetic dentistry procedures are performed on both hard and soft tissue to correct either subjectively or objectively, patient perceived deformities. Perceptions of esthetic deformities or needs are highly subjective. In this article an effort has been made to outline the possible esthetic errors which occur in the absence of careful treatment planning during the fabrication of fixed partial denture procedure.

Keywords: Esthetic Failures, Shade Selection, Gingival Esthetics, Esthetic Smile.

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Introduction

The surge of interest in the use of tooth-colored restorative materials and systems in recent years has been attributed partly to rapid developments in dental materials science and also to patient demand and operator interest. When overall dental appearance is considered, several factors are of significance, including tooth color, shape, and position; restoration quality; and the general arrangement of the dentition, especially of the anterior teeth. Each factor may be considered individually, but all components together act in concert to produce the final esthetic effect. However, although the clinician must be mindful of the patient's desires for a favorable cosmetic result, materials and techniques must be carefully selected, and restorations should be sufficient to withstand the forces of occlusion and mastication and provide long-term function and esthetics.

The elective nature of esthetic procedures requires that the patient is thoroughly educated about possible risks and adverse consequences along with need for dedicated maintenance. The proper selection of treatment occurs through a comprehensive dialogue between the Prosthodontist and the patient in which both subjective and objective evaluations are utilized to determine appropriateness of treatment and thus enable the assumption; of reasonable risk / benefit ratio. The irreversibility of many esthetics procedures requires that the patient be fully aware of future additional and / or alternative treatments if their initial esthetic goals are not met. In this article an effort has been made to outline the possible esthetic errors which occur in the absence of careful treatment planning during the fabrication of fixed partial denture procedure.

Evolution of Ceramics as an Esthetic Alternative

The metal-ceramic crown was introduced to the profession over four decades ago. At the time there was tremendous excitement generated by the concept because it theoretically combined the esthetics of the porcelain jacket crown with the potential for clinical longevity.

However, it is likely safe to state that most clinicians were somewhat disappointed by the initial clinical results obtained with this treatment modality. It is highly likely that most early esthetic failures with metal-ceramic restorations were due to a combination of errors in tooth preparation, cervical margin design and soft-tissue management. Nevertheless, the disappointment with metal-ceramic restorations was the genesis...
for the development of numerous all-ceramic alternatives to the metal-ceramic restoration. The past two decades has witnessed the unprecedented introduction of alternatives to the metal ceramic crown. In addition, many different techniques for fabrication of all-porcelain labial margins have been developed to improve the inherent esthetic performance of metal-ceramic restorations. In clinical situations with sufficient remaining enamel, etched porcelain laminate veneers may also be considered to restore the teeth to both optimum esthetics and function.

Thus, the contemporary host of indirect alternatives for the esthetic restoration of anterior teeth. It is also clear that ceramic technology has matured to the point that it is possible to mimic nature and provide restorations that defy detection to even the trained observer.

Classification of Esthetic Errors

(Richard E. Lombardi; 1974)
I. Inharmonious dento-facial ratio
   1. Shade disharmony
   2. Compositional incompatibility
      • Static prosthesis in dynamic mouth
      • Inharmonious strength or weakness of dental composition compared to background features.
      a. Weak mouth with strong face.
      b. Strong mouth with weak face.
II. Intrinsic dental disharmony
   1. Space allocation errors
      • Inadequate vertical space allocation
      • Excessive vertical space allocation
      • Excessive horizontal space allocation
   2. Structural line errors
      • Elevated occlusal plane
      • Occlusal plane drops down posteriorly
      • Asymmetrical occlusal plane
   3. Unnatural lines
      • Reverse smiling line
      • Unnatural axial inclination
      • Cusp less posterior teeth
      • Gradation errors
      • Age-sex personality disharmony
   4. Single-line errors
      • Vertical deviation
      • Horizontal deviation
      • Line conflict
   5. Imbalance

Factors Affecting Esthetic Failures

One of the goals of any dental restoration should be patient satisfaction. The restoration should fulfill the requirements of correct mastication function, appropriate morphology, superficial staining, abrasion and other characterization. Finally, the shade selected must correspond to the individual, age related appearance of the patient and should be identical to the remaining natural teeth. Problems that arise during fabrication can be overcome in spite of the difficulty level, which varies from case to case and depends in part on whether the restoration involves a single crown or a fixed partial denture. A general requirement for the success of laboratory work by the dentist (i.e.; proper shade selection, correct tooth preparation and final impression).

Tooth Shape

The facial surface of the tooth is a part of tooth form. It is decisive in shaping tooth's appearance, particularly when severe changes occur in old age. The incisal edge, which may be slightly convex in shape initially, changes as well. As a consequence of abrasion it may eventually become concave. All of these variable characteristics of tooth shape combine to determine the effect of the tooth in the mouth, to a significantly greater degree than does the shade. The changes in the cervical region, through gingival recession for example, also lead to an appearance typical of a certain age. These changes have a more pronounced effect on the appearance of the dental arch than on the shade.

Because the gingiva usually recedes interproximally as well, it leaves the crown of the tooth with a more triangular appearance. If these teeth are replaced by a restoration having a square form, they will appear more unnatural. It is expected that the form of the clinical crown correspond to the course of the root, which is often exposed because of periodontal disease.

Surface Structure and Characterizations

The natural surface detail is most extensive in a young tooth. Many fine, detailed
irregularities occur, particularly on the labial surface. At the first glance one sees horizontal depressions. Vertical lines become visible with more careful observation, so that a pattern of very fine, slightly displaced rectangles is seen.

The older a tooth becomes, the less prominent these structure become. Millions of lip movements in the same direction lead to formation of large smoothed regions between which few structured zones are retained. Enamel tears, abrasions, discoloration, incisal edge irregularities, bright spots, and band-shaped shade variations are not the only characterizations that must be evaluated.

Cervical erosions and fine lines that separate the clinical crown and the root, which may result from simple aging or from oral hygiene procedures, must also be evaluated.

Color
Nature of Color: When we talk about color, we are making reference to a sensation which is captured by our eyes. The human eye is an organ specialized in the reception of images obtained from an electromagnetic radiation that we refer to as light, and which actually corresponds to a narrow segment of the entire spectrum, situated between the 400 and 800 nm wavelengths approximately, and which we perceive as the so-called “colors of the rainbow”.

Radiations below these wavelengths are not visible to the human eye, and are referred to as ultraviolet; those which are situated above these wavelengths are not visible either, and are referred to as infrared.

There are generally three accepted dimensions of color:
- Hue, tonality: this indicates the feature which is normally referred to as color, directly related to the wavelength of the observed luminous radiation observed (e.g. red, green, blue, yellow...).
- Value, luminosity: this expresses the amount of light that makes up the color under study, and would be like the black and white image of the observed object, corresponding to the tonalities of grey ranging from a maximum value, white, and a minimum value, black.
- Chroma, saturation: this refers to the amount of dye that the color contains, the chromatic brightness that we observe. This dimension refers to the different dilutions of the base color we are starting from.

To these three dimensions, and within the field of dentistry, we must add a fourth one which would include all of the chromatic features that personalize the tooth apart from its average color, and which are fundamental for the reproduction of the color of a tooth.

Gingival Esthetics
Factors Affecting Gingival Esthetics: The morphology and dimension of supracrestal periodontal tissues undoubtedly represent the most important parameters to be taken into consideration in designing a fixed prosthesis.

Esthetic Width; As the supracrestal connective tissue attachment is resected during tooth preparation, so should the esthetic width be respected when designing the prosthetic framework, a distinct space is necessary between the coronal border of the gingiva and the cervical margin of the framework to provide adequate room for the application of specific shoulder porcelain.

The Umbrella Effect; A careful analysis of clinically relevant optical phenomena should always include the effect produced by the lips, particularly the upper lip, because this feature will significantly influence the interaction of light with the teeth and their supporting tissues. When the lips are retracted, the apical extension of the framework generally will not have a strong impact on the optical behavior of the crown, because the light can be directly distributed into the tissues.

When the upper lip is in its normal position, however, the difference becomes significant, because direct penetration of light into the surrounding periodontal tissues is prevented. In contrast, an adequately reduced framework does not demonstrate the so-called umbrella effect.

Esthetic Smile
The smile is expressed by muscular action around the lips in the inferior third of the face by a brightening of the eyes. The pleasing smile is one of our special forms of nonverbal communication, and it expresses joy.

The elements that effect in an esthetic smile are:
- The upper lip position
- The upper lip curvature
• The parallelism of the anterior incisal curve with the lower lip
• The relationship between the maxillary anterior teeth
• The number of teeth displayed in a smile

The most attractive smiles have nearly perfect harmony between the arcs of curvature of the incisal edges of the maxillary incisor and the upper border of the lower lip, and the upper lip can be at the height of the gingival margin of the maxillary central incisor. It was found that in an attractive smile, the full shape of the maxillary anterior teeth was displayed between the upper and power lip. The upper lip curved upward or was straight, the maxillary anterior incisal curve was parallel to the lower lip, and the teeth were displayed to the first molar.

SHADE SELECTION FAILURES

To date, there is no systematic training on visual shade determination for dental technicians or dentists. Therefore; all attempts to improve the color communication fail at this barrier.

The many difficulties associated with visual shade determination of manufactured or customized shade tabs for natural teeth are further complicated by the fact that color interpretation by the human eye is influenced by a variety of factors.

Shade selection is an important procedure to provide patients with an aesthetic restoration that harmoniously blends to the patient’s existing dentition. Knowledge of the scientific basis of color from understanding light to also interpreting the artistic aspects of shade selection ensures a successful result. Shade selection involves the perception of color, which depends on three entities:

1. Light
2. Object; and
3. Visual detection

The visual system of the eye is only capable of detecting wavelengths from 380 (violet) to 780nm (red). Isaac Newton showed that light had no color, as it is only when it interacts with an object that color is produced.

Light

The color of an object can change depending on the illuminant, e.g. tungsten light may cast a yellow color compared to daylight. The property of light source to influence color of objects is called “color rendition”. There are three main illuminants within any dental practice: natural, incandescent and fluorescent.

Natural sunlight is itself variable with light appearing blue at noon when the sun has fewer atmospheres to penetrate and red/orange during the morning and evening. Incandescent lighting is predominantly red/yellow and lacking in blue while fluorescent lighting is high in blue tones and low in red. There are special that are color corrected to emit light with a more uniform distribution of color that can be utilized. Initial shade selection should be initially made with be matched under different lights to avoid metamerism (the phenomenon that occurs when shades appear to match under one lighting condition and not another).

Factors Affecting Light Conditions

• Gingival shade
• Influence of the surroundings
• Type and arrangement of the shade guide
• Position of the shade tab
• Different color perception capacities
• Knowledge about color and its perception
• Experience in shade selection
• Acting mechanism of the eye (simultaneous contrast, contrast increase)

When determining a color, the human eye perceives a certain shade; however, under modified light conditions, the color perception and the subsequent shade selection can be completely different. This implies that when shade guides are used exclusively, the tooth shade required is always described in an insufficient manner.

It is important to use auxiliary tools and a shade indicator that is arranged according to a logical system oriented by the natural model.

Object

Color possesses three dimensions: value, hue and chroma. A high value object often reflects most of the light falling on its surface and appears bright. The converse is true with a dark object absorbing most of the light and appearing dull or of low value. Hue is wavelength of light, and dependent on the spectral reflectance from an object. Chroma is the concentration of color or color intensity.
Visual detection

The third part of stimulus for color is the spectral response of the detector, or eye. The difficulty of shade selection is that clinicians must be able to interpret a multi-layered structure of varying thickness, opacities and optical surface characteristics. This can affect the way that the eye perceives color. The basic hue of the tooth is determined by the color of the underlying dentine, while value is a quality of the enamel overlay. 

Muia in 1993 stated, “The dentine imparts the entire color. Enamel is like a fiberoptic structure conducting light through its rods”. Chroma is the saturation of color in the dentine, but is influenced by the value and thickness of the enamel. Teeth are often termed “polychromatic” and have the variation in hue, value and chroma within the teeth and give three dimensional depth and characteristics. A young dentition is characterized by opaque, high value enamel, which blocks underlying dentine. As teeth age, the enamel becomes more translucent and dull (low value) revealing the underlying dentine. This layering can make reading of tooth color difficult since the value of enamel and surface luster often complicate color evaluation of the underlying dentine.

Contrast Effect

When a dental restoration is being fabricated, the surroundings of the teeth, especially the shade of the gingival tissues, are decisive for the color integration of the restoration. With the conventional visual shade determination, so-called simultaneous contrast effects and contrast increases occur. To explain briefly: Shade selection is performed in a reddish environment-skin, lips, and gingival tissues. This environment, and especially the reddish-violet color of the gingival tissues, leads to a marked decrease in the receptiveness of this area to the color spectrum. The brain replaces the apparent excess of red with the complementary shades green to yellow. This leads to a subjectively modified color perception, which expresses itself in a tendency toward seemingly objective yellowish shades. This contrasting effect can be neutralized by the use of a gingival mask.

Tips to Remember During Shade Selection Procedure

- Shade selection should be completed before preparation as teeth can become dehydrated and result in higher values.
- Shades should be done when the dental team is not fatigued as in the end of the day.
- Ensure surgery surroundings are of neutral color so that there is no color cast onto the teeth.
- Remove lipstick; ask patients not to wear lurid clothing or any items that may distract the attention of the teeth.
- Make sure teeth are clean and unstained before attempting shade selection.
- Patient should be in an upright position at a level similar to the operator and the shade guide should be at arms length. This ensures that the most color sensitive part of the retina will be used.
- Observations should be made quickly (5 seconds) to avoid fatiguing the cones of the eyes. If longer than this, the eye cannot discriminate and the cones become sensitized to complement the observed color.
- Blue fatigue can accentuate yellow sensitivity so dentists can look at a blue object, bib, etc, while resting the eyes.
- Use color corrected light illumination, which should be of a diffuse nature.
- Choose basic shade at the middle of the tooth - using the Vita System 3D-Master technique of value, chroma then hue. Viewing tabs through half-closed eyes can decrease ability to discriminate color but increases the ability to match value. Look at the other parts of the teeth, dividing the teeth into nine sections from apical to incisal and mesial to distal.
- Necks of shade tabs often can be removed as they have a great deal of colorants that may introduce errors.
- Examine tooth for translucency and any characterizations, e.g. craze line, hypocalcification, etc.
- Create a shade/chromatic map – divided into different sections to ensure correct placement of different effects, characterizations and shades.
- In case of color blindness, seek the help of the assistant
- Shade selection is done before tooth preparation
- Don't dry the tooth while selecting the shade
- Moisten the shade tab
- Canine is the darkest tooth
• Premolars are of lighter shade than canine
• For premolar select contra-lateral premolar
• When maxillary anteriors are missing, shade of the mandibular anteriors are considered
• In case of a non-vital tooth, cover it and select the shade of the adjacent tooth.
• Photograph teeth and tabs using different lighting conditions to minimize metamerism, e.g. flash (5500K) and natural daylight (6500K).
• Photograph teeth at 1:1 ratio for detailed characterizations.
• Send digitized images and shade map to ceramist.

Stump shade selection
With the increasing use of all-ceramic restorations, it is important to communicate the prepared tooth or "stump" shade to the ceramist so that they can build the restoration with the right opacity/translucency. It may be necessary as in to use a more opaque ceramic to block out discoloration, e.g. an alumina- or zirconia based restoration may be a better choice than a glass-based ceramic like Empress.

Although no single shade guide or combination of guides includes all of the color combinations that may be encountered in clinical practice, a reasonably high level of clinical color matching has been achieved, which attests to the artistic skills of many dentists in selecting the best available shade and determining what color modifications are necessary to further enhance the color match.

Instrumental Shade Selection
Given the great subjectivity that predominates all during the color measurement process in the clinic, a series of electronic instruments designed to facilitate and make more objective the process of color measurement have recently been appearing on the market. The practitioner thus needs only to use these devices in order to be able to indicate the tooth's color in a more precise, reliable and repeatable way.

Knowledge of the correct use of the conventional color measurement systems is becoming more and more important if we wish to satisfy present day esthetic demands.

This, together with the gradual entry and perfection of the electronic color meter systems, will serve to reduce the possibilities of aesthetic failure, and thus increase the quality of restorations.

Table 1. Commercially Available Digital Shade Guides.

<table>
<thead>
<tr>
<th>Shade guide</th>
<th>Area of measurement</th>
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</thead>
<tbody>
<tr>
<td>Digital Shade Guide (Rieth)</td>
<td>Spot</td>
</tr>
<tr>
<td>Easy shade (Vita)</td>
<td>Spot</td>
</tr>
<tr>
<td>ShadeEye-NCC (Shofu)</td>
<td>Spot</td>
</tr>
<tr>
<td>ICAM (DCM)</td>
<td>Complete tooth</td>
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<tr>
<td>Complete tooth Shadescan (Cynos)</td>
<td>Complete tooth</td>
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<tr>
<td>Complete tooth Shadevision (X-Rite)</td>
<td>Complete tooth</td>
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<tr>
<td>Spectroshade (MHT)</td>
<td>Complete tooth</td>
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As a summary reasons for esthetic failures can be summarized as following.
• Failure to identify patient expectations regarding esthetics
• Improper shade selection
• Failure to transfer the shade to dental laboratory
• Excessive metal thickness at incisal and cervical region
• Thick opaque layer application
• Surface blistering ("chalky" appearance)
• Over glazing or too much smooth surface
• Metal exposure in connector, cervical and incisal regions
• Dark space in cervical third due to improper pontic selection (Anteriors)
• Failure to produce incisal and proximal translucency
• Improper contouring
• Failure to harmonize contra-lateral tooth morphology
  1. Contour
  2. Color
  3. Position
  4. Angulations
• Discoloration of facing

The contemporary restorative dentist has a host of options with which to help his or her patients are treated. Many of these options are considerably less invasive than many of our conventional restorative therapies. Many patients present for esthetic restorative treatment, and are becoming increasingly sophisticated in their expectations of the final results. Additionally, manufacturers are bringing a myriad of new products to the market, often accompanied by a blizzard of information purported to demonstrate the benefits and efficacy of these new products.
Careful evaluation of patient’s expectations and needs and proper choice of materials and techniques along with sound knowledge and skill of the operator can decrease the failures in the esthetic outcomes in fixed partial dentures.

Conclusions

Today’s dental restoration is consolidated around three mainstays: the use of non-metallic materials, such as composite resins and ceramics; adhesion to dental structures; and the achievement of a natural cosmetic look. The level of esthetic requirement and demand by patients in restorations has risen spectacularly in recent years, and this has made it necessary for dental professionals to explore this field in order to satisfy the existing social demand in this area. The dental materials that are available nowadays offer us the possibility of imitating the tooth’s natural esthetic look, so long as the right one is chosen for a given situation. The first step to achieving clinical success in esthetic dentistry will therefore be to correctly identify the patient’s needs and to imitate tooth color with the material that most closely matches, and to communicate this information to the laboratory if the restoration is to be carried out there.

Color measurement may seem to be a minor element within the field of Restorative Dentistry, but its importance is essential, although not from the biological point of view. But given the present day level of esthetic exigency, a technically correct restoration can be a clinical failure if it fails to achieve the esthetic integration the patient nowadays demands.

Declaration of Interest

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