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Esthetics in Orthodontics: A review

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ABSTRACT: The overall esthetics of the face can affect how dental esthetics are judged. Orthodontists have long-understood that evaluating macroesthetics, miniesthetics and microesthetics play an important role in providing the best care. This review article gives a brief introduction to all the components of macro, micro and mini esthetics.
KEY WORDS: Orthodontic tooth movement, Drugs, Hormones, NSAIDs, Bisphosphonates, Prostaglandins, Bone resorption, Bone deposition.

INTRODUCTION

Esthetics is the study of beauty and, together with ethics, logics, politics, and metaphysics is a branch of basic philosophy.Dentofacial attractiveness is particularly important to a person's psychosocial wellbeing. Those with poor dental esthetics have been linked to lack of self-confidence and are thought to be disadvantaged in social, educational, and occupational settings. Tatarunaite et al (AJODO 2005)[1] reported that smiling and youthful facial appearance make women look more attractive.During interpersonal interactions, the eyes primarily scan other people's eyes and mouths, with little time spent on other features. (Miller, 1970)[2]

The esthetic paradigm[3]

A paradigm can be thought of as "a set of shared beliefs and assumptions that represent the conceptual foundation for an area of science or clinical practice". -esthetic outcome was critical for patient satisfaction.contemporary orthodontist- 3 spatial dimensions and a fourth dimension: Time

The Golden proportion/Divine Proportion[4]

Fibonacci Numbers-The increase in numbers occurred as if by adding the last two numbers together in a series.eg-0,1,1,2,3,5,8,13,21,34,55….. and so on. Each new addition is precisely 1.618 times the previous number, and this ratio of addition continues on to infinity.Also, each previous number in this series is 0.618 times the next number.This 1.618 ratio of the Fibonacci numbers forms the basis of the Golden Section.

The Golden Section-The satisfactory division of a surface into parts that are different in shape and size, yet related to each other is called a 'repeated ratio'.The most significant repeated ratio in history is the 'Golden Proportion', it was called Phi/ Divine Proportion.Its value is **1.618 : 1**

Genetic implications of the Logarithmic spiral and the Golden Section[5] -The logarithmic spiral is found in the simplest of primitive forms, the snails.

Clinical applications of the divine proportions[5] -A golden relationship between the corpus axis (Xi-Pm) and the condylar axis (Xi-Co), which makes the mandible a beautiful pleasing structure.In every normal composite of mandible studied, the corpus axis was in the divine proportion to the condylar axis when measured to the top of the condyle. (Figure 1,2)

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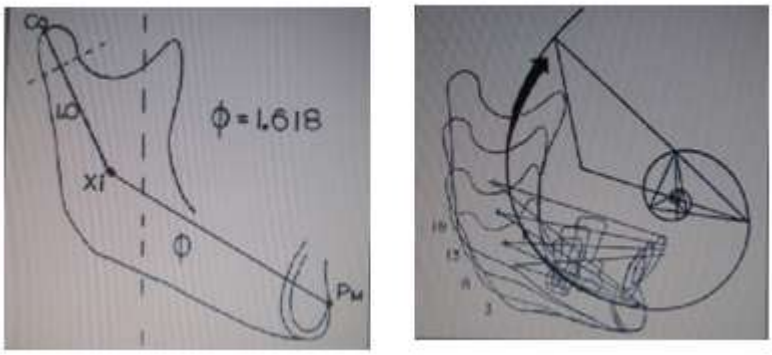

Figure 1 and 2: A golden relationship between the corpus axis (Xi-Pm) and the condylar axis (Xi-Co), which makes the mandible a beautiful pleasing structure

Table 1- Evaluation of Facial and Dental Appearance - Smile esthetics[6,7]

Macroesthetics	**Mini-Esthetics**	**Micro esthetics**
Facial Proportion Vertical & Horizontal	Smile analysis- smile arc	Tooth proportions- Height-width relationships
FacialBalance and Symmetry	buccal corridors	Gingival heights shape and contours.
Facial Profile - Profile Analysis	Amount of gingival and incisor display	Connectors and embrasures.
Evaluation of lip posture and incisor prominence	Tooth lip relationships	Tooth shade and colour.

Macroesthetics[6,7]

The face in all three planes of space (macro-esthetics). Examples of problems that would be noted in that first step would be asymmetry, excessive or deficient face height (vertical proportion), mandibular deficiency or excess, etc.

Facial Proportion

1. Vertical Division(Figure 3)

Vertical facial proportions in the frontal and lateral views are best evaluated in the context of the facial thirds. The face is ideally divided into equal thirds:

- Upper: tragion toGlabella
- Middle: opharic to subnasion
- Lower: subnasion to gonion

The lower third of the face is further divided into two unequal parts:

a) Subnasion to commissures of the lips is equal to one-third of thesubnasion to gonion

b) Commissures of the lips to the gonion is equal to two-thirds ofsubnasion to gonion

Increase lower one-third height - a) Vertical maxillary excess b) Class III malocclusion

Decreased lower one-third height- a) Vertical maxillary deficientb) Mandibular retrusion

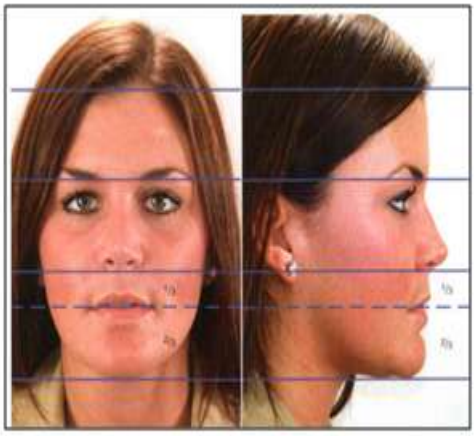

Figure 3: Vertical Division

2. Horizontal Division[6](Figure 4)

An ideally proportional can be divided into central, medial, and lateral equal fifths. The separation of the eyes and the width of the eyes, which should be equal, determine the central and medial fifths.

The nose and chin should be centred within the central fifth; with the width of the nose the same as or slightly wider than the central fifth.

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The inter-pupillary distance (dotted line) should equal the width of the mouth.

Figure 4: Horizontal Division

B) Balance and Symmetry

Facial symmetry is defined by the facial midline. The midline runs through the centre of the face and a philtrum of the lip (cupid's bow), dividing it into right and left sides. The more symmetric and identical the sides, the closer they come to bilateral duplication or mirror images, the more inherently harmonious and beautiful the face (horizontal symmetry).

C) Facial Profile - Profile Analysis

1. Throat form and Mandibular plane angle(Figure 5)

Throat form is an important factor in establishing optimal facial esthetics, and poor throat form is a major contributor to esthetic impairment in patients with mandibular deficiency.

The inclination of the mandibular plane to the true horizontal should be noted. The mandibular plane is visualized readily by placing a finger or mirror handle along the lower border. (Figure 6)

A steep mandibular plane angle usually indicates long anterior facial vertical dimensions and a skeletal open bite tendency,

Figure 5: Throat form

Figure 6: Mandibular plane angle

A flat mandibular plane angle often correlates with short anterior facial height and deep bite malocclusion

2. Establishing whether the jaws are proportionately positioned in the anteroposterior plane of space(Figure 7)

Inphysiologic natural head position, With the head in this position, note the relationship between two lines, one dropped from the bridge of the nose to the base of the upper lip, and a second one extending from that point downward to the chin.

These line segments should form a nearly straight line.

An angle between them indicates either profile convexity (upper jaw prominent relative to chin-skeletal Class II)

or profile concavity (upper jaw behind chin-skeletal Class III).

If the profile is approximately straight, it does not matter whether it slopes either anteriorly (anterior divergence) or posteriorly (posterior divergence).

Divergence of a straight profile line does not indicate facial or dental disproportion

Divergence of the face (the term was coined by the eminent orthodontist- anthropologist Milo Hellman) is influenced by the patient's racial and ethnic background.

Divergence of the face is defined as an anterior or posterior inclination of the lower face relative to the forehead.

- American Indians and Asians- anteriorly divergent faces
- Northern European- divergent

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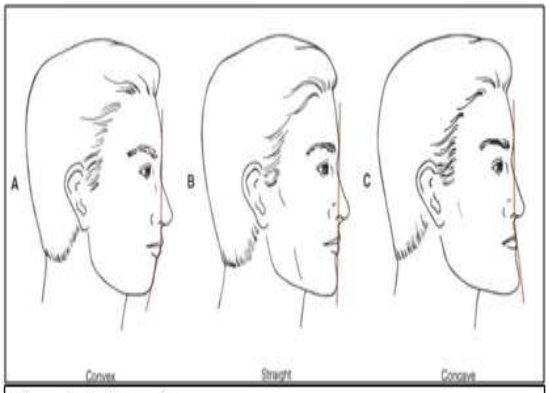

Figure 7: Facial profile

3. Evaluation of lip posture and incisor prominence

Like facial divergence, lip prominence is strongly influenced by racial and ethnic characterises.

- Whites of northern European - relatively thin lips, with minimal lip and incisor prominence
- Whites of soutern European and middle eastern - more Iip and incisor prominence
- Greater degrees of lip and incisor prominence - Asians and African

The teeth protrude excessively if:the lips are prominent and everted, and the lips are separated at rest by more than 3 to 4mm (which is sometimes termed lip incompetence).

- i.e., excessive protrusion of the incisors is revealed by prominent lips that are separated when they are relaxed, so that the patient must strain to bring the lips together over the protruding teeth- For such a patient, retracting the teeth tends to improve both lip function and facial esthetic.(Figure 8)

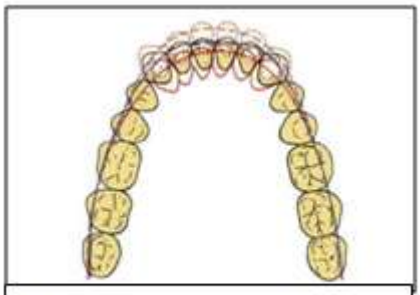
Figure 8: Evaluation of lip posture and incisor prominence

- If the lips are prominent but close over the teeth without strain- the lip posture is largely independent of tooth position. For this individual, retracting the incisor teeth would have little effect on lip function or prominence.

Lip posture and incisor prominence should be evaluated by viewing the profile with the patient's lips relaxed (Figure 9)


Figure 9: Lip posture and incisor prominence

- upper lip to a true vertical line passing through the concavity at the base ofthe upper lip (soft tissue point A)
- the lower lip to a similar true vertical line through the concavity between the lower lip and chin (soft tissue point B)

- If the lip is significantly forward from this line, it can be judged to be prominent; if the lip falls behind the line, it is retrusive.
- If the lips are both prominent and incompetent (separated by more than 3 to 4 mm), the anterior teeth are excessively protrusive.

The larger the nose, the more prominent the chin must be to balance it, and the greater the amount of lip prominence that will be esthetically acceptable. Short lower face height have everted and protrusive lips because they are over-closed and the upper lip presses against the lower lip, not because the teeth protrude

Mini-Esthetics[6,7,8,9]

The smile framework is bordered by the upper and lower lips on smile animation and includes such assessments as excessive gingival display on smile, inadequate anterior tooth display, inappropriate gingival heights, and excessive buccal corridors.

Tooth lip relationships

It is important to evaluate not only the characteristics of face, but also the relationship of the dentition to the face.

- Symmetry- the relationship of the dental midline of each arch to the skeletal midline of that jaw. Dental casts show the relationship of the midlines to each other but no information about the dental-skeletal midlines.
- Vertical Characteristics - dental to soft tissue relationship- vertical relationship of the teeth

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to the lips, at rest and on smile, Amount of incisor display should be noted.

- Transverse cant of the occlusal plane- Up-down transverse rotation of the dentition on smiling, and at rest a transverse cant of occlusal plane/ transverse roll of the esthetic line of the dentition.

Transverse cant may be the result of differential eruption and placement of anteriors or skeletal asymmetry of the mandible producing in a compensatory maxillary cant. Smile asymmetry may be due to soft-tissue considerations, - during smiling, there is a differential elevation of the upper lip

Smile analysis

Facial attractiveness is defined more by the smile than by soft tissue relationships at rest.There are two types of smiles:

1. The posed or social smile- reproducible-voluntaryexpression,focus of orthodontic diagnosis
2. The spontaneous/emotional smile- varies with the emotion being displayed

In smile analysis, the oblique view, frontal and profile views are important.Three things need to be considered:

The smile arc.[6]-The smile arc is defined as the contour of the incisal edges of the maxillary anterior teeth relative to the curvature of the lower lip during a social smile. For best appearance, the contour of these teeth should match that of the lower lip. If the lip and dental contours match, they are said to be consonant.A flattened smile arc is less attractive in both males and females and it makes the patient look older (because older individuals often have wear of incisors that tend to flatten the arc of the teeth).

Smile index- Ackerman and Ackerman developed-describes the area framed by the vermilion borders of the lips during the social smile. It is determined by dividing the intercommissure width by the interlabial gap during smile. (Figure 10)

Figure 10: Smile index

Vertical Characteristics- Amount of gingival and incisor display.(Lip Line)[6]

Lip Elevation- In smiling, the upper lip is elevated by about 80% of its original length, Women have 3.5% more lip elevation than men. Elevation of the upper lip on smile should stop at or near the gingival margin, so that all of the upper incisor is seen. Some display of gingiva is acceptable, and can be both esthetic and youthful appearing.Lip elevation that does not reach 100 % display of the incisor crowns is less attractive, display of 75% of the crowns is about the minimum for excellent esthetics, and it is better to display some gingiva than too little of the incisor crowns.Excessive incisor display, the usual cause is a long lower third of the face, but of course that is not the only possibility-a short upper lip could produce the same thing, Recording lip height at the philtrum and the commissures can clarify the source of the problem.

Lip Line- amount of vertical tooth exposure in smiling, height of the upper lip relative to the maxillary central incisors.A high lip line-exposes all of the clinical crowns plus a contiguous band of gingival tissue- "gummy smile" as undesirable----- low lip line displays less than 75% of the maxillary anterior

Transverse Dimensions of the Smile Relative to the Upper Arch

A broad smile may be more attractive than a narrow one,The amount of buccal corridor that is displayed on smile, that is, the distance between the maxillary posterior teeth (especially the premolars) and the inside of the cheek.Excessively wide buccal corridors - called "negative space-widening the maxillary arch can improve the appearance of the smile if cheek drape is significantly wider. The transverse width of the dental arch - should be related to the width of the face. The width of the maxillary dental arch, as seen on smile, should be proportional to the width of the mid-face. A broad smile is appropriate for a face with relatively large width across the zygomatic arches, while a narrower smile is preferred when the face width is narrow.

Micro esthetics[7,10,11]

The teeth (micro-esthetics)- includes assessment of tooth proportions in height and width, gingival shape and contour, connectors and embrasures, black triangular holes, and tooth shade.Following entities are included in the micro esthetics:

1. **Tooth proportions**

Smile reveals the maxillary anterior teeth and two aspects of their appearance: the tooth widths in relation to each other, and the height/width proportions of the individual teeth.Width Relationships and the "Golden Proportion. The apparent widths of the maxillary

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anterior teeth on smile, and their actual mesio-distal width, differ because of the curvature of the dental arch. For best appearance, the apparent width of the lateral incisor (as one would perceive it from a direct frontal examination) should be 62% of the width of the central incisor, the apparent width of the canine should be 62% of that of the lateral incisor, and the For best appearance, the apparent width of the lateral incisor (as one would perceive it from a direct frontal examination) should be 62% of the width of the central incisor, the apparent width of the canine should be 62% of that of the lateral incisor. This ratio of recurring 62% proportion also appears in other relationship in human anatomy and is known as Golden Proportions

Height-Width Relationships (Figure 11)- Most authors define the height/width ratio of 0.80 for the upper central incisor (which represents the key tooth to esthetical composition of the smile). The ideal maxillary central incisor should be approximately 80% width compared with height, but it has been reported to vary between 66-80%.A higher width/height ratio means a squarer tooth, and a lower ratio indicates a longer appearance.The tooth disproportion is due to:

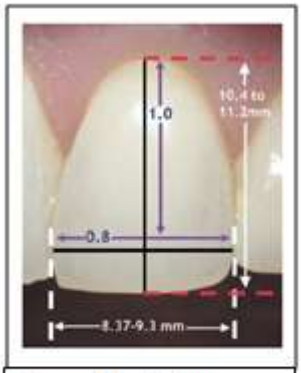

Figure 11: Height-Width Relationships

- inherent distortion in crown form (which suggests a more extensive restoration, with facial laminates or a complete crown)
- loss of crown height from attrition in an older patient (which may indicate restoration of the missing part of the crown)
- incomplete eruption in a child (which may correct itself with further development)
- excessive gingival height (best treated with crown lengthening)

Gillen et al - proportions of width among the upper anterior teeth: a) lateral incisors have 78% of the width of the central incisor; b) lateral incisor has 87% of the width of the canine; c) canine has 90% of the width of the central incisor. The relation of proportion between the crown heights of anterior teeth proposed by Gillen et al. is widely used. It suggests that the height of the clinical crown of the upper lateral incisor must be 82% of the height of the crowns of the central incisor and canine. Therefore, canines and upper central incisors would have the same anatomical crown height. This study was used to justify the bonding of orthodontic brackets at the same height for canines and upper central incisors, during placement of the orthodontic appliance.

2. Gingival height, shape & contours (Figure 12)

Proportional gingival height is necessary to produce a normal &attractive dental appearance. The central incisor has the highest gingival level, lateral incisor is 1.5 mm incisal and canine is at the same level as central incisor.This is important to maintain this gingival relationship in finishing all orthodontic cases and also when tooth substitutions are planned. A difference of more than 2 mm in the gingival height is recognised by both dentist and lay person. Gingival shape refers to curvature of gingiva at the margin of the tooth.

For best appearance, the gingival shape of the maxillary lateral incisors should be a symmetrical half-oval or half-circle. The maxillary centrals and canines should exhibit a gingival shape that is more elliptical and oriented distally to the long axis of the tooth.Correcting the gingival contours removes the excess gingival covering the clinical crowns and helps improve display of teeth and improves gingival contours and shape. This is carried out with gingivectomy procedure. Gingival contouring can now be carried out effectively with the use of a diode lasers-wavelength of 810-980 nm

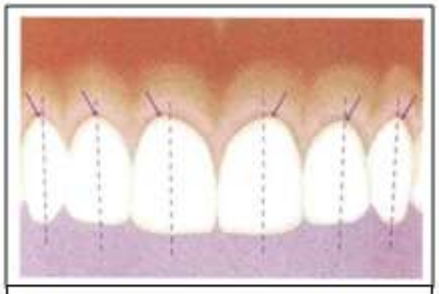

Figure 12: Gingival height, shape & contours

Working of a laser- Lasers cut by thermal ablation-decomposition of tissue through an instantaneous process of absorption, melting, and vaporization. Essentially, the cells of the target tissue absorb the concentrated light energy, rapidly rise in

temperature, and produce a micro-explosion known as spallation.

3. Connectors and embrasures(Figure 13)

Contacts are defined as the exact place where the teeth touch.

Connector is where the incisors and canines appear to touch.

Morley & Eubank- Connector areas are larger, broader areas than the contact points between teeth and can be defined as the zone in which two adjacent teeth appear to touch.

The most aesthetic relationship of connector area between the maxillary anterior teeth is referred to as the 50-40- 30rule. This rule defines the ideal connector area between the two maxillary central incisors as 50% of their clinical crown length, the ideal connector area between central and lateral is 40% of central incisor clinical crown length and between lateral and canine it is 30% of clinical crown length of central incisor.

The most important connector area is the one between two maxillary central incisors and should be maintained in orthodontically treated cases.

Figure 13: Connector area

Embrasures: Black Triangles- The embrasures (the triangular spaces incisal & gingival to the contact) ideally are larger in size than the connectors and the gingival embrasures are filled by the interdental papillae. Short interdental papillae leave an open gingival embrasure above the connectors called "black triangles" which give an unesthetic appearance of the teeth during smile. In adults, they arise due to loss of gingival tissue related to periodontal disease, but when crowded and rotated maxillary incisors are corrected orthodontically, the connectors move incisal and black triangles may appear. Reshaping of teeth by orthodontic root paralleling and flattening of the mesial surfaces of the central incisors, followed by space closure, will lengthen this contact area and move it apically toward the papilla and correct the black triangle

4. Tooth shade and colour

Aging brings about changes in the tooth colour and shade. In Young age teeth appear lighter and brighter. As age advances the teeth appear darker & duller. This is due to the formation of secondary dentin as pulp chambers decrease in size and thinning of enamel leads to decrease in its transparency and a greater contribution to darker shade. A normal progression of shade changes from midline posteriorly is an important contributor to an attractive & natural appearing smile. The maxillary central incisors tend to be the brightest in a smile, lateral incisor less bright &canines the least, 1st and 2nd premolar are lighter and brighter than the canines and closely match lateral incisors.

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