

## ■ *Review Article*

# Principles of Smile Analysis in Orthodontics- A Clinical Overview

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### Abstract

“It all begins with a smile” is a proverb which, highlights the importance of smile in social outlook and quality of life. With the face first paradigm, orthodontics has put more emphasis on the dental and facial appearance as it has a direct psychosocial impact. Modern orthodontics deals with not only the traditional dental and skeletal aspects but soft tissue drape or face as first priority. Orthodontic treatment planning must incorporate various principles of smile analysis to achieve desirable results. This article describes principles of smile analysis that should be considered during orthodontic treatment planning and various attributes of a pleasing smile.

**Keywords:** smile analysis, esthetic paradigm, smile arc

### Introduction

The importance of beauty and attractiveness in today’s society has been well established. Physically attractive people are perceived to be more kind, sensitive, interesting, strong, poised, modest, sociable, outgoing, exciting and responsive<sup>1,2</sup>. It is also believed that attractive people are more likely to obtain better jobs, have more successful marriages, and experience happier, more fulfilling lives. These societal biases begin early in life and impact a person’s future for a lifetime<sup>3</sup>. Dentofacial attractiveness is particularly important to a person’s psychosocial well being. People with a normal dental appearance are judged more socially attractive over many personal characteristics than those with malocclusions. 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<sup>4,5,6</sup>. This article reviews concepts and principles of smile esthetics in orthodontic treatment that should lend esthetics to the entire orofacial complex involving unity, form, colour, function and display of dentition.

### Historical aspects

The study of frontal facial form dates back to the Egyptians, who depicted ideal facial esthetics as the “golden proportion.” This concept has been described extensively in classical art and orthodontic literature. Edward Angle’s emphasis on occlusion led him to teach that optimal facial esthetics always coincided with ideal occlusion and that esthetics could essentially be disregarded because it took care of itself. Also, the early concepts of esthetics revolved largely around the patient’s profile, and it was believed that, once the “ideal” tooth–jaw positions were achieved, then the soft tissues would fall in line. This focus on the profile was because the lateral cephalogram has long been the lynchpin of orthodontic treatment planning. As a result, orthodontics tended to drift away from clinical examination of the patient and the art of physical diagnosis. But perhaps more attention should be paid to his inclusion of art in the orthodontic search for quantifying facial beauty<sup>7</sup>.

### Esthetic paradigm in modern orthodontic treatment planning

In the 1980s, the introduction of new esthetic materials in restorative dentistry led to the widespread adoption of “esthetic dentistry.” At about the same

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time, it became clearer to all involved that orthognathic surgical goal setting was esthetically driven. This has led to the emergence of the esthetic paradigm in orthodontic treatment. Today's "art of the smile" is being driven by the orthodontist's ability to clinically examine the patient in 3 dimensions and use the latest technology (computer databasing of the clinical examination and digital videography) to document, define, and communicate the treatment strategy to patients and colleagues involved in interdisciplinary care<sup>8</sup>.

The contemporary orthodontist no longer evaluates patients in terms of only the profile, but also frontally and vertically, to complete the 3 spatial dimensions, and statically and dynamically<sup>9,10</sup>. Also, the orthodontist must now add a fourth dimension: Time. Orthodontists are the first in line in a decision-making process that ultimately affects a patient's appearance for the rest of his or her life. The orthodontist must understand not only dentoskeletal growth and development, but also soft tissue growth, maturation, and aging<sup>11,12</sup>.

### Smile records<sup>13,14</sup>

3 categories of orthodontic records

- Static records (Photographs)
- Dynamic records (Video)
- Direct biometric measurements

### Photographs

In addition to the standard frontal at rest, frontal smile and profile at rest images, Sarver and Ackerman<sup>13</sup> recommend 4 additional views:

- Profile smile
- Oblique smile
- Frontal smile closeup
- Oblique smile closeup

### Dynamic recording is accomplished with digital videography

- Digital video and computer technology enables the clinician to record anterior tooth display during speech and smiling at the equivalent of 30 frames per second.
- 5 seconds of video for each patient may be taken, yielding 150 frames for comparison.
- One segment of video is taken in the frontal dimension and one from the oblique view.

### Direct measurement as a biometric tool

- Quantification of resting and dynamic lip-tooth relationships is critical to smile visualization.
- Direct measurement also has application in research efforts relative to time related changes and the repeatability of the social smile.
- Tooth-lip relationships

Systematic measurement of resting tooth-lip relationships virtually leads the clinician to a quantified treatment plan.

The following frontal measurements should be performed.

- Philtrum and commissure height,
- Interlabial gap,
- Incisor show at rest and smile,
- Crown height, Gingival display,
- Smile arc<sup>13,14</sup>.

### Tooth lip relationship and smile incisor show at rest and smile

The amount of maxillary incisor show at rest is a critical parameter esthetically, because it is an inevitable characteristic of aging. As a general guideline, in adolescents 3-4 mm of the maxillary incisor should be displayed at rest, and the entire clinical crown with some gingiva should be seen on smiling<sup>15</sup>. Generally, males show less upper incisors and more of lower incisors, while females show more of upper incisors and less of lower incisors. Peck et al<sup>16</sup> showed that the normal display of maxillary incisors with relaxed lips at 15 years age is  $4.7 \pm 2$  mm for boys and  $5.3 \pm 1.8$  mm for girls. This sexual dimorphism is evident at all ages. Excessive tooth display is judged better at rest than on smile, because lip elevation on smiling is quite variable. If exposure at rest is normal, even if a considerable amount of gingival display occurs on smiling, this should be considered normal for that individual<sup>17</sup>. Dong et al<sup>18</sup> compared the age changes in maxillary and mandibular incisor display at rest and when smiling and found that aging (from 30 years to 60 years) was associated with a steady decrease in maxillary incisor display and a concomitant increase in mandibular incisor display.

### Crown height

The percentage of incisor display, when combined with crown height, helps the clinician decide how much tooth movement is required to improve the

smile index<sup>19</sup>. Crown height is the vertical height of the maxillary central incisors; in adults, crown height is normally between 9 and 12 mm, with an average of 10.6 mm in men and 9.6 mm in women. The age of the patient is a factor in crown height because of the rate of apical migration in the adolescent<sup>20,21</sup>.

### The Smile arc

The smile arc from the frontal view is the relationship of the curvature of the incisal edges of the maxillary incisors and canines to the curvature of the lower lip in the posed social smile<sup>22,23,24</sup>. In an ideal smile arc, the curvature of the maxillary incisal edge is parallel to the curvature of the lower lip upon smile; the term *consonant* describes this parallel relationship<sup>25</sup>. In a *nonconsonant* or flat smile, the maxillary incisal curvature is flatter than the curvature of the lower lip on smile<sup>26</sup>. Tjan et al<sup>27</sup> in a survey of young Los Angeles adults, found that a great majority (85%) had a maxillary incisal smile curve parallel to the inner contour of the lower lip, 14% showed a straight rather than a curved line, and only 1% had a reverse smile curve.

### Multidimensional analysis of smile frontal dimension

To visualize and quantify the frontal smile, Ackerman and Ackerman<sup>28</sup>, developed a ratio, called the smile index, that describes the area framed by the vermilion borders of the lips during the social smile. The smile index is determined by dividing the intercommissure width by the interlabial gap during smile. This ratio is helpful for comparing smiles among different patients or across time in 1 patient. Frontally, we can visualize and quantify 2 major dimensions of the smile: vertical and transverse characteristics. The vertical characteristics of the smile are broadly categorized into 2 main features: those pertaining to incisor display and those pertaining to gingival display. If, for example, the patient shows less than 75% of the central incisor crowns at smile, tooth display is considered inadequate<sup>29</sup>.

Other vertical smile characteristics are the relationships between the incisal edges of the maxillary incisors and the lower lip, and between the gingival margins of the maxillary incisors and the upper lip<sup>30</sup>. The gingival margins of the canines should be coincident with the upper lip and the lateral incisors positioned slightly inferior to the adjacent

teeth. It is generally accepted that the gingival margins should be coincident with the upper lip in the social smile. However, this is very much a function of age, because children show more tooth at rest and have more gingival display on smile than do adults<sup>31,32</sup>.

There are three types of smiles described in the literature according to lip coverage of maxillary incisors in full smile<sup>27,33,34</sup>.

1. The average smile, that reveals 75-100% of the upper incisors (most frequent).
2. The low smile which displays < 75% of the maxillary incisors (found in 20% of population.)
3. High/ gummy smile, revealing the complete cervicoincisal length of the upper incisors and a contiguous band of gingiva.(10% of the population)

### Transverse characteristics

The transverse characteristics of the smile in the frontal dimension are

- Arch form,
- Labiolingual crown-inclinations of teeth,
- Buccal corridor and
- Transverse cant of the maxillary occlusal plane.

**Arch form** plays a pivotal role in the transverse dimension of the smile. Recently, much attention has been focused on the use of broad, square arch forms in orthodontic treatment. When the arch form is narrow or collapsed, the smile may also appear narrow and therefore present inadequate transverse smile characteristics. An important consideration in widening a narrow arch form, particularly in adults, is the axial inclination of the buccal segments. Patients whose posterior teeth are already flared laterally are not good candidates for dental expansion. Patients with upright premolars and molars have more capacity for transverse expansion; This is true in adolescents, but it is particularly important in adults because sutural expansion is less likely<sup>35,36</sup>.

### Labiolingual crown inclinations

Generally 90% of people show the 1<sup>st</sup> or 2<sup>nd</sup> premolar as the last tooth when smiling. To create the illusion of smile fullness, the last premolar should be positioned relatively upright. Torque prescriptions for most preadjusted appliance systems tend to create too much lingual crown inclination, which may not

be optimal from the esthetic perspective. Crown inclination symmetry of contralateral teeth contribute to an optimally esthetic appearance., and necessary archwire correction bends should be made to achieve this<sup>35</sup>.

### **Buccal corridors**

The transverse smile dimension is also related to the lateral projection of the premolars and the molars into the buccal corridors<sup>37</sup>. The buccal corridor may be defined as “ The distance from the posterior teeth to the corners of the lips “.

Frush and Fisher considered the buccal corridor to be a normal feature of a dentition that prevents the “Sixty tooth Smile” that is often characteristic of a denture.They stated that the size and shape of the buccal corridors were not important, as long as the buccal corridors were noticed.The wider the arch form in the premolar area, the greater the portion of the buccal corridor that is filled.Only a few studies have determined the esthetic value of the buccal corridor space<sup>38,39</sup>.

### **Transverse cant of the maxillary occlusal plane.**

Transverse cant can be due to differential eruption and placement of the anterior teeth or skeletal asymmetry of the mandible resulting in a compensatory cant of the maxilla. Only frontal smile visualization permits the orthodontist to visualize any tooth-related or skeletal asymmetry transversely. Smile asymmetry may also be due to soft tissue considerations, such as an asymmetric smile curtain. In the asymmetric smile curtain, there is a differential elevation of the upper lip during smile, which gives the illusion of a transverse cant to the maxilla. It is poorly documented in static photographic images and is documented best in digital video clips<sup>28</sup>.

### **Oblique dimension**

The oblique view of the smile shows characteristics of the smile not obtainable on the frontal view or through any cephalometric analysis<sup>40</sup>. The palatal plane can be canted anteroposteriorly in a number of orientations. In the most desirable orientation, the occlusal plane is consonant with the curvature of the lower lip on smile. Deviations from this orientation include a downward cant of the posterior maxilla, upward cant of the anterior maxilla, or variations of both<sup>41</sup>. This is best visualized in the oblique view.

The visualization of the complete smile arc afforded by the oblique view expands the definition of the smile arc to include the molars and the premolars<sup>39</sup>

### **Sagittal dimension**

The 2 characteristics of the smile that are best visualized in the sagittal dimension are overjet and incisor angulations. Excessive positive overjet is one of the dental traits most recognizable to the lay person. In many Class II patterns, the smile is esthetic frontally, but the problem is obvious when observed from the side. In Class III patterns too, the frontal smile looks esthetic but the oblique or sagittal view shows the underlying skeletal pattern and dental compensation. Incisor proclination in the sagittal dimension can also have a dramatic effect on incisor display. In simple terms, flared maxillary incisors tend to reduce incisor display, and upright maxillary incisors tend to increase it<sup>26</sup>.

### **The fourth dimension: time**

The growth, maturation, and aging of the perioral soft tissues have a profound effect on the appearance of both the resting and smiling presentations. In preadolescent patients, the facial soft tissues are still in a growth phase, and treatment decisions pertaining to the relative facial divergence at profile and frontal facial soft tissue topography must take this into account. Adolescent patients, or those at the point of pubertal onset, have experienced the maximum velocity in the growth of the skeletal subunits and have roughly achieved their facial soft tissue “look.”In adults, nuances in the aging of perioral and facial soft tissues become increasingly important. It is known from orthodontic cephalometric research that, on average, profiles flatten over time<sup>28</sup>.

### **Conclusion**

Today, well occluding casts and pleasing profiles can no longer be considered to be adequate treatment goals for the orthodontist. Since most people interact with each other facing each other directly or obliquely, the smile of the patient should be given adequate importance in treatment planning. In order to correctly diagnose and treat problems associated with the smile, meticulous clinical observation and record taking in the form of photos and videos is warranted, in various dimensions.

## References

1. Dionk K, Berscheid E, Walster E. What is beautiful is good . J Personality and social Psychology.1972;24:285-90.
2. Ekman, P. Darwin and Facial Expression: A Century of Research in Review, Academic Press, New York, 1973.
3. Kostianovsky A. The unpleasant smile. Aesth. Plast. Surg.1977; 1:161.
4. Mugohzibwa et al. Perception of Dental attractiveness and orthodontic treatment needs among Tanzanian Children. Am J Orthod. And Dentofac. Orthop.2004;125(4):426-34
5. Kokich VO, Kiyak HA, Shapiro PA. Comparing the perception of dentists and lay people to altered dental esthetics. J. Esth. Dent.1999; 11:311-324.
6. Kim US, Kim IP, Oh SC, Dong JK.. The effect of personality on the smile. J. Wonkwang Dent. Res. Inst.1995; 5:299-314.
7. Verma N, Valiathan A. An understanding of facial esthetics and its role in orthodontics. Kerala Dental Journal 2006; 29(3): 27-30.
8. Janzen EK.. A balanced smile: A most important treatment objective. Am.J. Orthod.1977; 72:359-372.
9. Rigsbee OH, Speny TP, BeGole EA. The influence of facial animation on smile characteristics, Int. J. Adult Orthod. Orthog. Snrg.1988; 3:233-239.
10. Powell, N, and Humphreys, B.: Proportions of the Esthetic Face, Thieme, New York, 1984
11. Sarver DM, Ackerman JL. Orthodontics about face: the reemergence of the esthetic paradigm. Am J Orthod Dentofacial Orthop 2000;117:575-6.
12. Arnett GW, Bergman RT. Facial keys to orthodontic diagnosis and treatment planning. Part II. Am. J. Orthod.1993; 103:395-411.
13. Sarver D, Ackerman M. Dynamic smile visualization and quantification: Part 1. Evolution of the concept and dynamic records for smile capture. Am J Orthod Dentofacial Orthop. 2003;124:4-12
14. Sarver D, Ackerman M. Dynamic smile visualization and quantification: part 2. Smile analysis and treatment strategies. Am J Orthod Dentofacial Orthop 2003;124:116-27.
15. Choi TR, Jin TH, Dong ZK. A study on the exposure of maxillary and mandibular central incisor in smiling and physiologic rest position. J. Wonkwang Dent. Res. Inst.1995; 5:371-379.
16. Peck S, Peck L, Kataja M. The gingival smile line. Angle Orthod 1992;62:91-100.
17. Vig PS, Cohen AM. Vertical growth of the lips: A serial cephalometric study. Am. J. Orthod. 1979; 75:405-415.
18. Dong JK, Jin TH, Cho HW, Oh SC. The esthetics of the smile: A review of some recent studies. Int. J. Prosthodont. 1999; 12:9-19.
19. Vig RG, Brundo GC. The kinetics of anterior tooth display. J. Prosth. Dent.1978; 39:502-504.
20. Hulseley CM. An esthetic evaluation of lip-teeth relationships present in the smile. Am J Orthod 1970;57:132-44.
21. Kim HS, Jin TH, Dong, J.K. A study on the relation between lip and teeth at smile in old aged Korean. J. Kor. Dent. Assoc.1993; 31:533-541.
22. Rubin LR. The anatomy of a smile: its importance in the treatment of facial paralysis. Plast. Reconstr. Surg.1974; 53:384-387.
23. Pale JL, Manktelow RT, Chsban R. The shape of a normal smile: Implications for facial paralysis reconstruction. Plast. Reconstr. Surg.1994; 93:784-789.
24. Philips E. The anatomy of a smile. Oral Health 1996; 86:7-13.
25. Garber DA, Saiama MA. The aesthetic smile: Diagnosis and treatment. Peri odontology .1996; 11:18-28.
26. Sarver DM. The importance of incisor positioning in the esthetic smile: the smile arc. Am J Orthod Dentofacial Orthop 2001;120: 98-111.
27. Tjan AH, Miller GD, The JG. Some esthetic factors in a smile. J Prosthet Dent 1984;51:24-8.
28. Ackerman MB, Ackerman J. Smile analysis and design in the digital era. J Clin Orthod 2002;36:221-36.
29. Yoon ME .Jin TH, Dong, J.K.. A study on the smile in Korean youth, J. Kor. Acad. Prosthodont. 1992;30:259-270.
30. Benson K.J, Laskin DM. Upper lip asymmetry in adults during smiling. J. Oral Maxillofac. Surg.2001; 59:396-398.
31. Morley J, Eubank J. Macroesthetic elements of smile design. J Am Dent Assoc 2001;132:39-45
32. Zachrisson BU. Esthetic factors involved in anterior tooth display and the smile: vertical dimension. J Clin Orthod 1998; 32:432-5
33. Miller CJ. The smile line as a guide to anterior esthetics. Deni. Clin. N. Am.1989; 33:157-164.

34. Philips E. The classification of smile patterns. J. Can. Dent. Assoc. 1999; 65:252-254.
35. Kim E, Gianelly A. Extraction vs Nonextraction: Arch Widths and Smile Esthetics. Angle Orthod 2003;73:354–358.
36. Johnson RD, Gallerano R, English J. The effects of buccal corridor spaces and arch form on smile esthetics . Am J Orthod Dentofacial Orthop 2005;127:343-50
37. Mabrito C. Elements of a beautiful smile. N.M. Dent. I.1996; 47:20-21.
38. Moore T, Southard K, Casco J, Qian F, and Southard T. Buccal corridors and smile esthetics. Am J Orthod Dentofacial Orthod 2005;127:208-13
39. Frush JP, Fisher RD. The dynesthetic interpretation of the dentogenic concept. J Prosthet Dent 1958;8:558-81.
40. Lackey AD. Examining your smile. Dent. Clin. N. Am.1989; 33:133-137.
41. Moskowitz ME, Nayyar A. Determinants of dental esth-etics: A rationale for smile analysis and treatment. Compend. Cont. Ed. Dent. 1995;16:1164-1166.