UNDERSTANDING & PROVIDING

Appropriate Line Angles to Optimize Smile Design Restorations

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Abstract

Successfully rehabilitating a patient's smile can be a rewarding experience for the patient and the entire restorative team. Because of the large investment by everyone involved, it is imperative for there to be a progression and completion of clinical and technical procedures that allow for a predictable result. In support of those procedures, the clinician and laboratory technician must possess knowledge that allows the replication of natural anatomic detail, including the principal structural manifestations commonly known as *line angles* or *transitional line angles,* in the design and fabrication of any restoration required. This article will define and identify line angles and how the clinician and laboratory technician can utilize them to the restorative team's advantage.

Key Words: line angle, embrasure, reflective surface, deflective surface, illusion

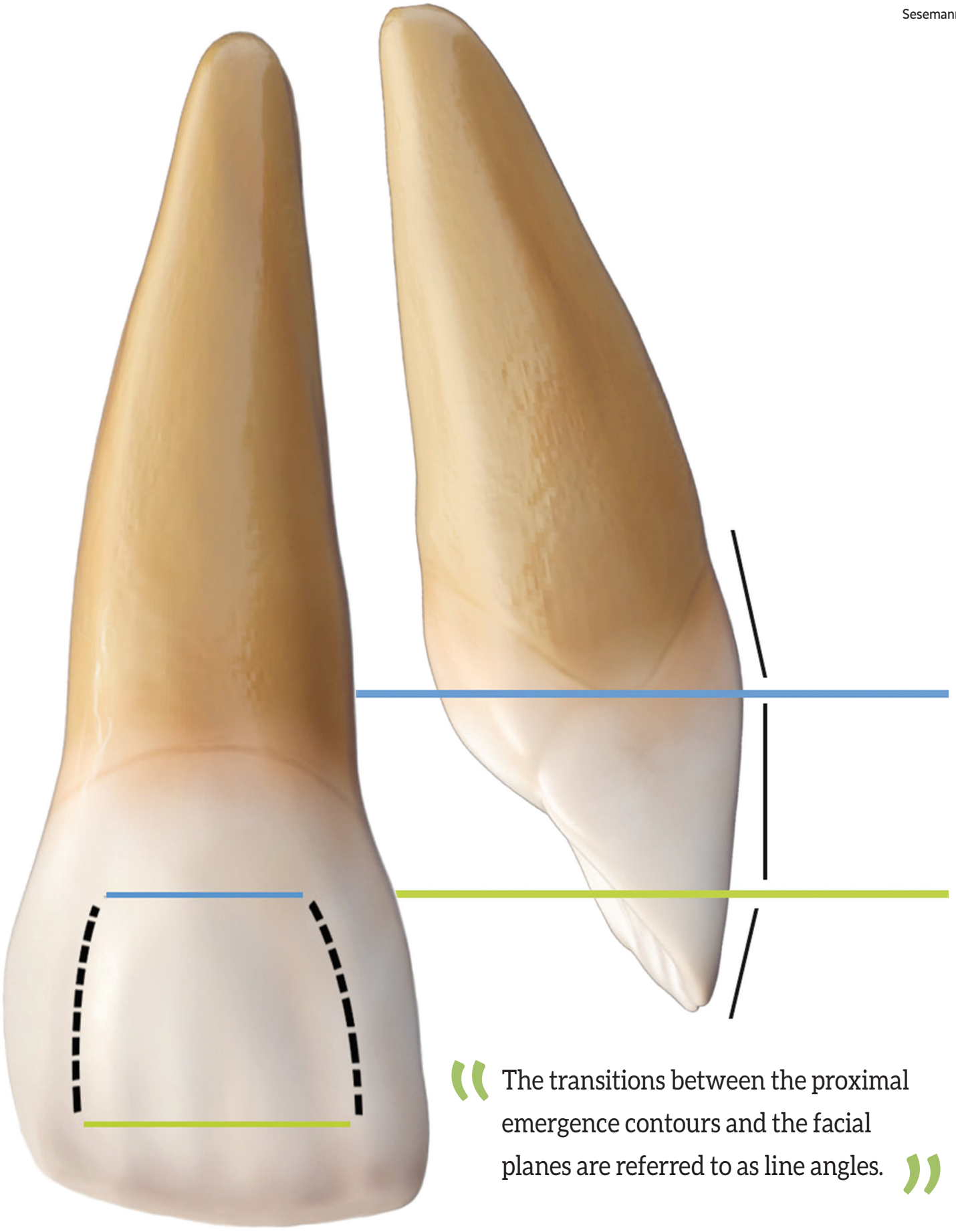
CE CREDIT

Learning Objectives

After reading this article, the participant should be able to:

1. Understand dental line angles and their importance in the visual perception of tooth form, size, and width.
2. Understand the interaction between placement of dental line angles and the size and geographical magnitude of a tooth's reflective and deflective surfaces.
3. Observe how the line angles of adjacent teeth interact with each other in the formation of embrasures and how this helps in the creation of natural and beautiful restorations.

Disclosures: The author did not report any disclosures.



> The transitions between the proximal emergence contours and the facial planes are referred to as line angles.

Introduction

Loosely defined, a *line angle* is the line at which two planes intersect. In dentistry, there are specific vertical and horizontal line angles related to the facial surfaces of anterior teeth that can affect visual perception of a single tooth, and of a smile through the visual relationships of the adjacent teeth in an arch. The mesiofacial, distofacial, incisofacial, and cervicofacial line angles will always be present on a three-dimensional tooth. Variations of line angle placement can make a tooth appear longer or shorter, and wider or narrower due to the change in the dimension of the reflective surface. The line angles of a single tooth define the size and geographical magnitude of the reflective and deflective surfaces. The line angles of adjacent teeth interact with each other to create embrasure forms that help a smile to appear optimal. The cervical and facial embrasures are distinctive spatial features that reside between the natural tooth forms of adjacent teeth. If attention is not paid to the shape of the embrasures and the subtle anatomic nuances they reflect, a restorative case can appear noticeably artificial.

Literature

Rufenacht wrote of the significance of lines and planes, and described the illusions that could be created by modifying restorations.[1] Chiche and Pinault described the perceived size of a tooth and how it could be changed by moving line angles in or out in conjunction with altering a tooth's facial contour.[2] Magne agreed and added that transitional line angles do not endure, unchanged, for life; rather, due to erosion and wear the position of the line angles can change and/or the prominence of the line angle contour can lessen over time.[3]

The word *illusion*, which can be defined as "a false perception; the mistaking of something for what it is not," enters often into a discussion of line angles. Line angles can be used to define a tooth's anatomical character but they also can be employed as a tool to create visual illusions that make a tooth appear to be something it is not. Gürel described how the proportion or orientation of teeth could be changed by the influence of either vertical or horizontal lines. He put forth that the perception of a tooth could be influenced by using either different colors in different internal planes or by enhancing the vertical and horizontal grooves related to the surface texture that could create "illusions that could fool the viewer's eyes."[4] Fradeani concurred with the existence of transitional line angles and how the movement of those lines could produce subsequent changes to the size of the light reflection areas, creating the impression of tooth size variation in the eye of the observer, even though the tooth perimeter had not actually been altered. He termed this an *illusory perception*.[5]

Accreditation

The American Academy of Cosmetic Dentistry's Accreditation Examination affirms that labial anatomy should mimic the morphology of the natural dentition. The transitions between the proximal emergence contours and the facial planes are referred to as line angles.[6] Line angle principles are addressed in 2 of the 44 criteria that Accreditation Examiners utilize to assess clinical case submissions. Criterion #42 asks the examiner to assess the Accreditation Candidate's portrayal of the facial anatomy with the submitted case with the questions, "Is the labial anatomy (primary, secondary, and tertiary) appropriate? Are there three planes for the labial contour of the central incisor? Criterion #43 simply directs the examiner to determine, "Have the line angles (of the case) been properly developed?"[6]

What constitutes the proper development of dental line angles? It seems that an understanding of the line angles of the human dentition is one of the essential elements that can help the restorative team masterfully reproduce a naturally beautiful result. However, many esthetic texts do not discuss line angles.

Line Angles of the Human Anterior Tooth

The line angles of the human anterior dentition that affect the visual character of a tooth are classified as mesiofacial (MF), distofacial (DF), incisofacial (IF), and cervicofacial (CF). The MF and DF line angles represent the vertical lines of intersection of the tooth's facial surface with the emerging mesial and distal interproximal surfaces **(Fig 1)**. If a tooth's facial surface is divided into three distinct planes—cervical, facial, and incisal—the IF and CF line angles represent the horizontal lines of intersection of the tooth's facial surface with the cervical and incisal planes, or surfaces **(Fig 2)**. In reality, the MF and DF line angles are slightly curved rather than linear when viewed from the frontal plane and the IF and CF line angles are more of a transitional curve when viewed from the sagittal perspective **(Fig 3)**.

Line Angles of the Dentition that Affect the Smile

Minor discrepancies between the facial and labial midlines are acceptable and in many instances imperceptible[7] if the midline is parallel to the midline of the face[8] and drops straight down from the papilla.[9] The author would put forward that the most important 20 square millimeters in smile design are located between the MF line angles of the central incisors at the level of the interproximal contact (calculated with the assumption that the interproximal contact between the central incisors is 5 to 6 mm in length).[10] When the MF line angles of each central are positioned equally in length and orientation (angulation) to the maxillary midline, the cornerstone for bilateral symmetry is set.[11] Bilaterally symmetrical MF line angles, oriented to a dental midline that is parallel to the midsagittal line of the face, create overall bilateral symmetry linking the face and dentition **(Fig 4)**.[12] When the MF line angles are at different contours (angulations, prominences, or distances to the dental midline) and/or are of different lengths, a dental midline will appear canted even if it is perfectly parallel with the midsagittal line of the face **(Fig 5)**.

In practice, patients appreciate a dental restorative makeover that corrects the visual tension created by dissimilar central incisor MF line angles **(Figs 6-8)**. The restoration of visual harmony can restore a patient's confidence and self-esteem.

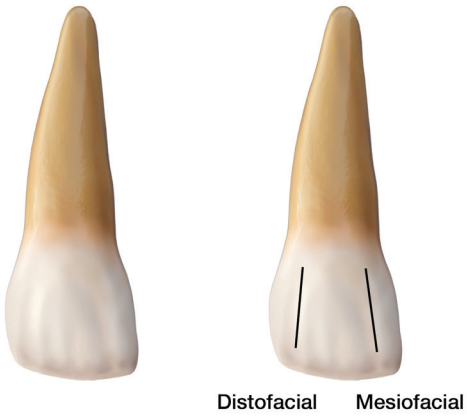


Figure 1: The mesiofacial and distofacial line angles of a tooth are vertically oriented, representing the intersection of the facial surface and the deflective surfaces emerging out of the interproximal contact.

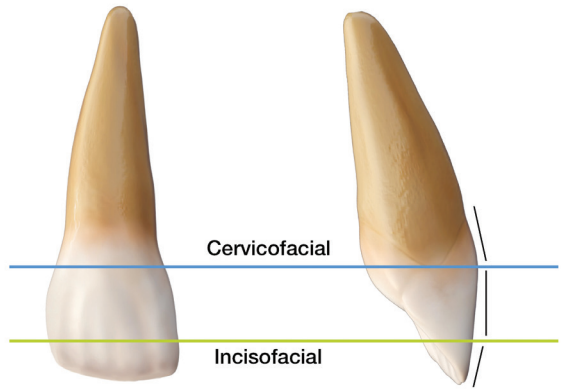


Figure 2: The central incisor's facial surface has three distinct planes. The intersections of the two planes shown here are horizontal representations termed the incisofacial and cervicofacial line angles.

Figure 3: The MF and DF line angles are curved, not linear when viewed from the frontal plane and the IF and CF line angles are more of a transitional curve when viewed from the sagittal perspective.

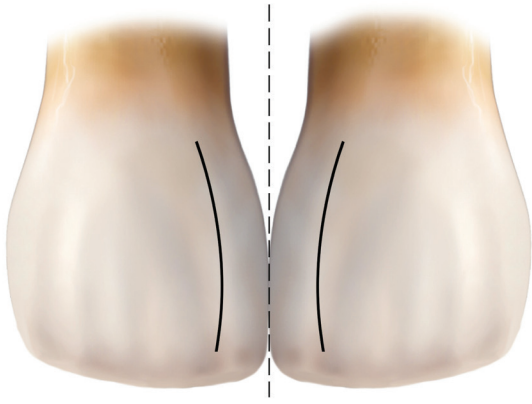


Figure 4: The most important 20 square millimeters in smile design occurs between the MF line angles of the central incisors at the level of the interproximal contact.

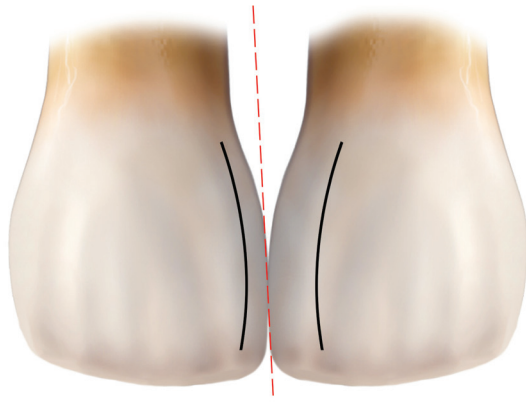


Figure 5: When MF line angles of the central incisors are bilaterally asymmetrical, a dental midline will appear canted even if it is perfectly parallel with the midsagittal line of the face.

Figure 6: Before image showing restorations that exhibit visual tension from disharmonic anatomic elements.

Figure 7: After treatment with aligner therapy and minimally prepared feldspathic veneers. *(Restorations created by Juan Rego, CDT, FAACD)*

Figure 8: Patient's confident smile after treatment.

> The line angles of the human anterior dentition that affect the visual character of a tooth are classified as mesiofacial, distofacial, incisofacial, and cervicofacial.

The Nuance of the Lateral Incisor

The orientation of the MF line angle of the maxillary lateral incisor and a slight depression of that tooth's distal line angle contour cause the lateral incisor to differ significantly from the central. The slight depression of the distal line angle at its cervical aspect creates a subtle contour effect **(Fig 9)**.

The lateral incisor adds significantly to the overall character of the smile. The line angle is at a stronger angle to the midline of the tooth when traveling incisocervically, revealing the mesial surface of the lateral incisor **(Fig 10)**. Changing the amount of mesial surface reveal by altering the placement of the MF line angle or by rotating the lateral incisor distally can affect the character of a restored smile. Conversely, making the reveal different from one side to the other creates a bilateral disharmony that can make a restored smile or denture tooth setup appear more natural. In the case of a denture, creating this bilateral dissimilarity by distally rotating one of the lateral incisors, revealing more of the mesial surface; or by "tucking in" the lateral incisor behind the adjacent central, revealing less of the mesial surface, helps create a feeling of natural disharmony that obviates the perception that a person has a denture restoration **(Fig 11)**.[13]

Altering Line Angles to Affect the Perception of Tooth Size

The facial plane, bounded by the mesial and distal line angles laterally and the incisal and cervical line angles (from above and below, respectively), is also known as the *reflective surface* **(Fig 12)**. This name derives from the fact that light striking its surface will return directly to the observer in the form of an image **(Fig 13)**, influencing a tooth's perceived length and/or width. Centering the reflective surface of the central incisor and making it bilaterally symmetrical creates a calm, confident visual presentation. Secondary anatomy (lobule definition) and tertiary anatomy (texturing) create sparkles of light that add to the visual effect, as shown in **Figures 14 and 15**.

A tooth's appearance can be changed by altering the size of the reflective surface through manipulation of the bordering line angles.[14] By moving the vertical line angles in or out, a tooth can appear narrower or wider horizontally. By changing the horizontal line angles toward or away from a tooth's center, the tooth can appear longer or shorter. An accepted listing of anatomical changes to create an illusory perception can be found in **Figures 16 and 17**.

Effects of Altering Line Angles

Alteration of line angles can affect embrasure character and the appearance of natural tooth contours. The MF and the DF line angles define the demarcation between the reflective and deflective surfaces of a tooth. The deflective surfaces of adjacent teeth define the anatomy of

Figure 9: A slight depression of the distal line angle at its cervical aspect creates a subtle contour effect.

Figure 10: Completed smile makeover illustrating the distinctive presence of the MF line angles of the lateral incisors. *(Restorations created by Pinhas Adar, CDT, AAACD)*

Figure 11: Creating bilateral disharmony with different rotational presentations of the lateral incisors conveys a natural-looking smile and helps a denture to visually appear as natural dentition. *(Prosthesis created by Arian Deutsch, CDT)*

Figure 12: The facial plane, or reflective surface, is bounded by the mesial and distal line angles laterally (from above) and the incisal and cervical line angles (from below).

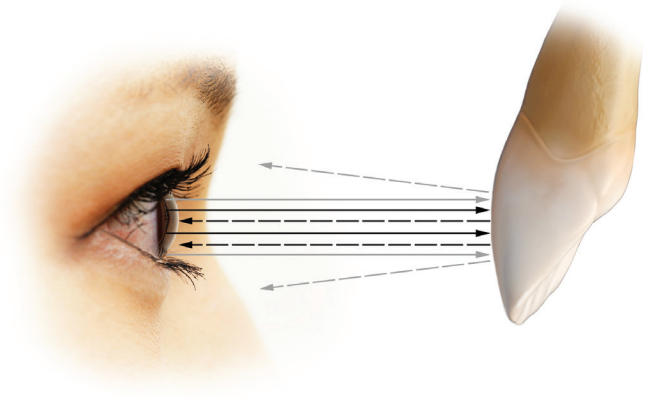


Figure 13: Light striking the reflective surface will return directly to the observer in the form of an image, influencing a tooth's perceived length and/or width.

Figure 14: Before image of a patient seeking a more esthetic prosthodontic result.

Figure 15: After image of the patient's smile displaying the dynamics created by the light reflecting off the reflective surface. *(Restorations created by Lee Culp, CDT)*

> "...the most important 20 square millimeters in smile design are located between the MF line angles of the central incisors at the level of the interproximal contact..."

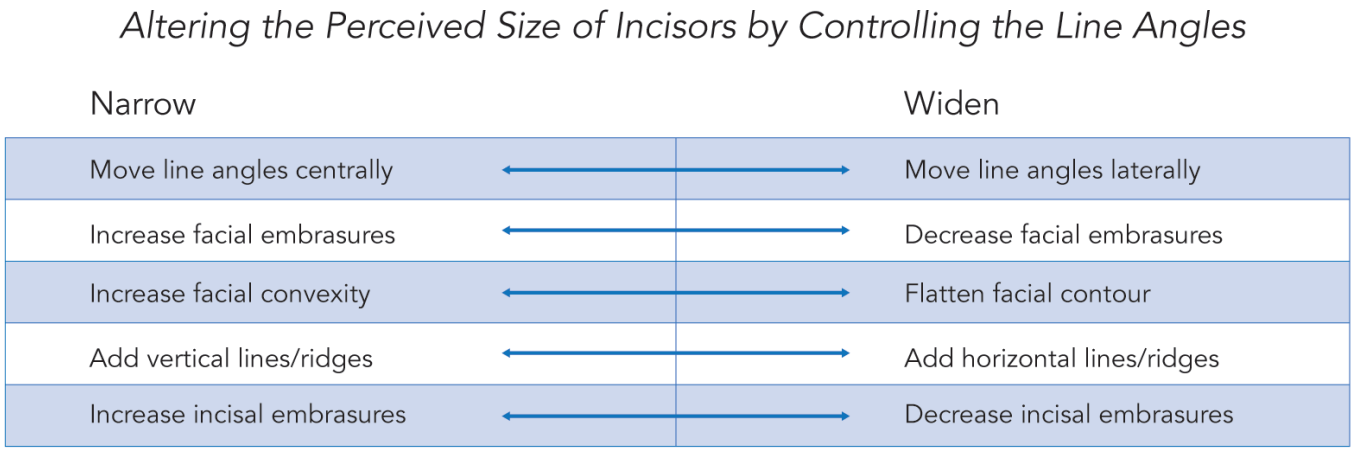


Figure 16: Ways in which the lateral perception of a tooth's size can be altered by changing the position of the MF and DF line angles.

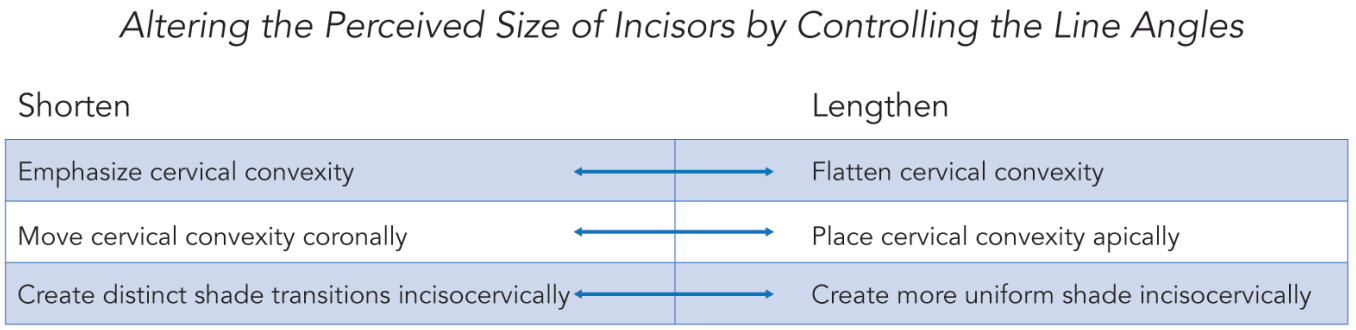


Figure 17: Ways in which the vertical perception of a tooth's size can be altered by changing the position of the IF and CF line angles.

the facial embrasure. An excellent vantage point to assess the shape of facial embrasures is from an occlusal view. A common issue when a clinician is fabricating direct composite veneers is the over finishing and/or polishing of the facial surface. This over finishing/polishing drives the line angles laterally toward the interproximal contact, increasing the width of the reflective surface and diminishing the existence of the facial embrasures. This is demonstrated in the before and after images from a Case Type V the author submitted for AACD Accreditation in 1998, which failed **(Figs 18-20)**. Development and retention of facial anatomy, lobule definition, and line angles create proper facial embrasures that best reflect the attributes of the natural dentition. Development of the facial embrasures can best be monitored and evaluated from the occlusal perspective **(Fig 21)**.

> "A tooth's appearance can be changed by altering the size of the reflective surface through manipulation of the bordering line angles."

Figure 18: Before image of a patient seeking direct bonded composite veneer restorations.

Figure 19: After image of direct bonded composite veneers—natural smile.

Figure 20: After image of direct bonded composite veneers; occlusal view illustrating wide reflective surfaces and line angles driven into the interproximal contact areas.

Figure 21: After image of direct bonded composite veneers; occlusal view illustrating correct placement of MF and DF line angles, creating more naturally developed facial and cervical embrasure forms.

Figure 22: Before image of composite bonding done by the author 17 years before replacing the composite bonding.

Figure 23: After image of direct bonded composite veneers performed by the author illustrating correct placement of MF and DF line angles, creating more naturally developed facial and cervical embrasure forms.

Summary

Understanding the line angles of the human dentition is one of the essential elements that can help the dental team masterfully reproduce a natural restorative result. For the clinician, composite bonding of the maxillary anterior teeth is a prime example of a clinical technique that tests this proposition. It is deeply gratifying to be able to provide natural-looking composite bonded restorations to our patients **(Figs 22 & 23)**.

Acknowledgment

The author is grateful to the AACD Accreditation Examiners who failed his submission for Case Type V in 1998. One of the primary reasons for the failing grade was the improper development of the line angles in the restorations. That failure challenged the author to carefully study and learn the nuances of dental anatomy in the service of his patients…and ultimately to fulfill the Accreditation criteria and receive a passing grade.

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> "Alteration of line angles can affect embrasure character and the appearance of natural tooth contours."

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AGD Subject Code: 780

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The examination is free of charge and available to AACD members only, and will be available for 3 years after publication for dentists, and 1 year after publication for laboratory technicians. AACD members must log onto www.aacd.com to take the exam. **Note that only Questions 1 through 5 appear in the printed and digital versions of the jCD; they are for readers' information only.** The complete, official self-instruction exam is available online only––completed exams submitted any other way will not be accepted or processed. A current web browser is necessary to complete the exam; no special software is needed. The AACD is a recognized credit provider for the Academy of General Dentistry, American Dental Association, and National Association of Dental Laboratories. For any questions regarding this self-instruction exam, call the AACD at 800.543.9220 or 608.222.8583.

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1. Which of the following line angles represent the vertical lines of interaction of a tooth's facial surfaces with the emerging mesial and distal interproximal surfaces?

a. mesiofacial (MF), distofacial (DF), incisofacial (IF), and cervicofacial (CF)
b. IF and MF
c. IF and CF
d. MF and DF

2. From which perspective is it best to evaluate the shape of facial embrasures?

a. directly from the front of the patient
b. from the left and right of the patient
c. from an occlusal view
d. during pronunciation of 'F' and 'V' sounds

3. What is the definition of a line angle?

a. The transition between the proximal emergence contour and the facial plane.
b. The transition between primary and secondary labial anatomy.
c. The transition between secondary and tertiary labial anatomy.
d. The angle at which light deflects from the facial surface of a tooth.

4. How do variations of line angle placement alter the visual perception of a tooth?

a. Placement of line angles alters the dimension of the reflective surface.
b. Line angle placement physically changes the length of a tooth.
c. Line angle placement physically changes the width of a tooth.
d. Modifying the line angles increases the light from the deflective surfaces.

5. The three planes of facial contour are separated by which of these lines or line angles?

a. MF and DF line angles
b. CF and IF line angles
c. gingival and incisal embrasure lines
d. MF, DF, CF, and IF line angles

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