Esthetics and Modern Removable Prosthodontic Restorations

With the heightened esthetic awareness of patients seeking modern dental therapy, the ability of prosthodontists to provide well-fitting, stable, functional and attractive removable prosthodontic restorations has never been more essential. Whether targeting a “natural” look or simply making improvements in cosmetic effect, knowledge of key elements of meaningful smile analysis—including tooth position, size and shape—and critical features that natural teeth display will assist dentists in achieving esthetic results with removable prosthodontics. This issue of Prosthodontics Newsletter looks at the historic scientific basis for frequently encountered dental esthetic factors.

Establishing Typical Smile Esthetics

While esthetics remains a major motivation for patients seeking dental treatment, cultural factors and individual preferences influence a person’s concept of beauty. Tjan et al from the University of Southern California designed a study to evaluate average desirable characteristic features of smiles and formulate a normative standard relative to

- smile type (high, average, low)
- parallelism of the maxillary incisal curve with the lower lip
- position of the incisal curve relative to touching the lower lip
- the number of teeth displayed in a smile

The authors evaluated 454 full-face photographs of dental and dental hygiene students (207 men, 247 women; age range, 20–30 years) with open smiles. Nearly 69% of the faces displayed a smile revealing 75% to 100% of the maxillary anterior teeth and the interproximal gingiva only, while 11% displayed a high smile (revealing the total cervicoincisal length of the maxillary anterior teeth and a contiguous band of gingiva) and 20% displayed a low smile (revealing <75% of the anterior teeth), a significant difference.

Parallelism of the upper incisal curve with the inner curvature of
Establishing Typical Smile Esthetics (continued from front page)

the lower lip was found in 85% of the participants; 14% showed a straight rather than a curved line, and 1% showed a reverse smile line. In roughly half the participants, the maxillary anterior teeth touched the lower lip. In 49% of the smiles, the 6 anterior teeth and the first premolars were visible; in 41%, the second premolars were also visible. First molars were visible in 4%, but 7% displayed only the 6 anterior teeth.

Comment
In this study, findings showed that an average smile exhibits approximately the full length of the maxillary anterior teeth, has the incisal curve of the teeth parallel to the inner curvature of the lower lip, has the incisal curve of the maxillary anterior teeth touching slightly or missing slightly the lower lip, and displays the 6 upper anterior teeth and premolars. These data may define an average smile, but they cannot define the most esthetically pleasing smile.


Symmetry in Maxillary Anterior Restorations

Designing prosthodontic restorations for the anterior teeth requires the practitioner to contemplate the question of symmetry. Should the dental midline match the facial midline? Miller et al from the University of Alabama School of Dentistry undertook a study to determine whether central incisors naturally fall symmetrically to the vertical center of the mouth and whether the midline of the mandibular teeth typically coincides with the midline of the maxillary teeth.

The authors analyzed the dentition of 500 randomly selected patients aged 12 to 70 years (271 white, 229 nonwhite) and found in 352 patients (70.4%), the midline of the maxillary dentition matched the median of the philtrum. No significant difference was found between men and women; however, the midline matched the philtrum in 74.5% of white patients, a significantly larger percentage than the 65.5% found in nonwhite patients. The midline of the maxillary dentition matched that of the mandibular dentition in 27.8% of cases; neither sex nor race differences significantly influenced this number (Table 1).

Comment
These results suggest that the maxillary dentition tends to be symmetrical to the philtrum and that the center of the maxillary dentition tends to fall at the exact middle of the mouth. However, the mandibular dentition infrequently lines up perfectly with the maxillary dentition. Ideally, using the location of the patient’s natural teeth would be the best guide for placement. When this information is unavailable, however, using the philtrum as a guide for placing maxillary anterior restorations should help create a natural appearance.


Natural-looking Anterior Tooth Exposure

Forty years ago, textbook recommendations for achieving proper placement and pleasing esthetics in full prosthodontic restorations focused on the length of the maxillary incisors. These guidelines failed to recognize that the lip length–incisal edge relationship is influenced by various factors specific to the individual patient. Nor did they take into account the amount of exposure of the mandibular anterior teeth. Vig and Brundo from the University of California School of Dentistry surveyed a large population to measure the amount of tooth displayed in the natural dentition with the lips gently parted.
When grouped by sex, race, age, lip type and upper lip length, women displayed almost twice as much maxillary incisor exposure as men (3.40 mm vs 1.91 mm). Although no differences based on race were found, expected differences based on lip length and type (i.e., people with short upper lips displayed more maxillary tooth structure than did people with long upper lips) were found.

Most important was the impact of a patient’s age on esthetics. Exposure of the maxillary central incisors decreased with age, from 3.37 mm in patients <30 years of age to –0.04 mm in patients ≥60+ years of age. Exposure of the mandibular central incisors increased from 0.51 mm to 2.95 mm at the same ages (Table 2).

**Comment**

This study’s findings dispute the concept of an acceptable “average” that can be used for anterior tooth restorations. The authors stressed that the measurements from this cohort should serve as a starting point for positioning anterior prosthodontic devices, not an answer for an individual patient’s needs.


### Ideal Gingival Margin in the Posterior Teeth

Among the elements that make up an esthetic natural smile are the appearance, contour and positioning of the teeth, gingiva and lips. Although limited information is available regarding the optimal configuration of gingival relationships for the anterior teeth, no studies have undertaken an analysis of the ideal gingival relationships for the posterior teeth, despite the fact that many people show a significant amount of their posterior dentition when smiling. Crawford et al from the Eastman Dental Hospital, United Kingdom, conducted a cross-sectional study that measured the impact of posterior gingival margin position on the perception of gingival margin relationships. Manipulated photographs showing various posterior gingival margin configurations were shown to patients with varying dental conditions and dentists.

The original image, a combination of a lower facial extraoral image and an intraoral image, adhered to reported esthetic ideals. The result was a life-size image that had coincident dental midlines bisecting the philtrum, a smile with 2 symmetrical halves, a low smile index giving the appearance of a youthful smile, 75% of the maxillary central incisors positioned below the lower border of the upper lip, a broad smile, acceptably proportional tooth width in the anterior dentition, maxillary central incisor dominance and a slight upwardly curving upper lip.

Assuming that the optimal gingival margin position would be just below the level of a zenith line linking the apical extent of the gingival margins of the canine and the first molar teeth, the life-size image was then modified. This was accomplished by adjusting the posterior gingival margins, shifting the first premolar gingival margin by 1-mm intervals (from –1 mm to +4 mm), while concurrently adjusting the second premolar by 0.75-mm intervals and the first molar by 0.5-mm intervals, resulting in 6 different photographs.

The 120 volunteers, all recruited from the authors’ institution, came from 4 groups:

- 30 patients with hypodontia (mean age, 20.6 years)
- 30 patients with periodontal disease (mean age, 49.3 years)
- 30 patients with neither condition (mean age, 37.4 years)
- 30 qualified dentists (mean age, 33.6 years)

On a 10-cm visual analog scale as part of a short questionnaire, all participants recorded their level of concern with their own dental appearance. Each participant was presented with the 6 photographs

<table>
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<th>Table 2. Tooth exposure by age</th>
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<td><strong>Mean amount of tooth exposed (mm)</strong></td>
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<td><strong>Age group (years)</strong></td>
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<tr>
<td>≤29</td>
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<td>30–39</td>
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and given up to 2 minutes to arrange the photographs from most attractive to least attractive. After a minimum time of 10 minutes, the participants were given the photographs again and asked to repeat their ranking.

More than half the dentists (63.3%) preferred the photograph with the first premolar gingival margins increased by 1 mm; at least half of each group preferred the photographs with 1- and 2-mm increases. The 4-mm increase was considered the least esthetically pleasing; the 1-mm decrease was also considered unattractive. No significant differences were found when participants were grouped by age, ethnicity, sex or perception of their own dental esthetics.

**Comment**
The zone of an esthetically pleasing gingival margin in the posterior dentition at the maxillary first premolar appears to extend 2 mm occlusally from a tangent line between the apical extents of maxillary canine gingival margins to the lower border of the upper lip superior to the first molar.


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**Defining an Accurate Ala-tragus Line**

Establishing the occlusal plane is a prerequisite when planning complete dentures. One popular method involves using the ala-tragus (Camper) line as a proxy for the occlusal plane. But not all ala-tragus line definitions agree. One definition measures the line from the inferior border of the ala of the nose to the superior border of the tragus of the ear, while another measures from the center of the ala to the center of the tragus. Because van Niekerk et al from the University of the Western Cape, South Africa, found all previous definitions of the ala-tragus line unsatisfactory, they set out to define an ala-tragus line that would more closely align with the occlusal plane while allowing sufficient space to arrange the maxillary molar teeth.

The authors fabricated and fitted 33 sets of complete dentures that satisfied the esthetic, functional and comfort needs of their patients based solely on criteria that did not rely upon the ala-tragus line. They then measured the functional occlusal plane using lateral cephalometric radiographs. The relationship between the occlusal plane and the ala-tragus line, which they defined as a line from the inferior border of the ala to the inferior border of the tragus, was measured, and the angle between them was given a positive value for posterior convergence.

The mean angle formed by the functional occlusal plane and the newly defined ala-tragus line was $2.45^\circ \pm 3.24^\circ$ (range, $+8.0^\circ$ to $-7.5^\circ$). The narrow difference between the measurements demonstrated the accuracy of their proposed definition for the ala-tragus line.

The less-experienced clinician may find it easier to use the ala-tragus line instead of intraoral reference points when the upper occlusion rim is trimmed to the occlusal plane. The conflicting definitions of the ala-tragus line affect the usefulness of this technique. This study’s authors ignored the ala-tragus line during the jaw registration and denture try-in. Checking the denture’s occlusal plane against the ala-tragus line only at the final visit, they found a close relationship between the 2 planes.

**Comment**
As defined by the authors, the ala-tragus line (the inferior border of the ala to the inferior border of the tragus) can be used as a simple and accurate surrogate for the occlusal plane during the planning of removable complete dentures. Ultimately, however, the position of the occlusal plane must satisfy esthetics, function and dental stability.


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**In the Next Issue**

Geriatric prosthodontics

Our next report features a discussion of these issues and the studies that analyze them, as well as other articles exploring topics of vital interest to you as a practitioner.

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