Objective: To determine the normal range for eyelid margin reflex distance (MRD) in adults according to their ethnicity, age, and sex.

Methods: A prospective study of eyelid measurements in 112 consecutive adult African American, Asian, white, and Latino patients was compared using t-test analysis. Measurements of MRD were collected by a single examiner across 5 months. Patients with conditions disposing to eyelid height changes were excluded.

Results: The MRD showed statistically significant variance among select ethnic groups. There was no statistical significance between sexes within each ethnic group.

Conclusions: Variance in MRD exists among ethnic groups. This information and further data on ethnicity and sex variance of eyelid measurements can be used for both diagnostic purposes and surgical treatment of patients for optimal results.

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Facial measurements are used in a variety of medical and surgical fields to diagnose and treat patients. Diagnosis of congenital malformations, metabolic diseases, aging changes, and trauma can all be made in part by knowledge of deviations from normal facial measurements. Surgical treatment of any of these problems clearly relies not only on anatomical knowledge but also on an understanding of the normal measurements for the patient based on their age, sex, ethnicity, and preferences. In the area of facial and plastic surgery, functional and aesthetically pleasing results rely on these fundamentals.

Data on a variety of facial measurements in adults and children have been published, although little information exists on eyelid measurements. Other publications include ethnicity in their analysis of facial measurements, but few studies include margin reflex distance (MRD). The MRD is the distance in millimeters from the corneal light reflex to the central upper eyelid margin with the patient in primary gaze. All MRD measurements were taken by a single examiner (A.P.M.) and recorded to the nearest 0.5 mm. All measurements were taken 3 times, and the mean of the 3 measurements was recorded. Exclusion criteria included thyroid eye disease, history of eye or eyelid surgery, history of trauma, contact lens wear, myasthenia gravis, Horner syndrome, congenital craniofacial anomalies, or use of dilating eyedrops, and 10 patients were excluded for these reasons. Ethnicity was determined by the patients' stated ethnic background.

Statistical analysis was performed using a 2-tailed t-test and linear regressions with the use of Stata statistical software (StataCorp, College Station, Texas).

The patients consisted of 50 women (49.0%) and 52 men (51.0%). The largest ethnic group was African American (41 patients [40.2%]), followed by white (27 [26.5%]), Asian (21 [20.6%]), and Latino (13 [12.7%]). The mean (SD) patient age was 50.6 (14.9) years, and patient ages were similar across ethnic groups (Table 1). The standard deviation of interpatient MRD measurements was 0.05; the mean of the measurements for each patient was reported. White patients had the highest mean MRD (5.1 mm) and Asians had the lowest [3.8 mm] (Table 1). We created histograms and box plots of MRD according to ethnicity (Figure 1 and Figure 2, respectively). The histograms show ethnic differences in MRD, particularly between whites and Asians, and we found substantial variability in MRD.
within each ethnic group (Figure 1). We draw the same conclusions from the box plots. However, within each ethnicity, sex did not make a significant difference in MRD (Figure 2).

Multiple linear regressions were performed \((\text{MRD} = \beta_0 + \beta_1 \text{female} + \beta_2 \text{African American} + \beta_3 \text{Latino} + \beta_4 \text{Asian} + \beta_5 \text{age} + \epsilon)\), with white male as the baseline group and having a confidence interval not containing 0. Using this model, we found significant differences in MRD among ethnic groups (Table 2). African Americans, Latinos, and Asians were expected to have lower MRDs than are whites of the same sex and age. However, no significant differences in MRD were found between African Americans and Latinos or between Latinos and Asians. Once again, sex was not found to be a predictor of MRD, although we found that more than 20% of the variability in MRD can be explained by ethnicity and age.

### Table 1. Patient Characteristics and Margin Reflex Distance (MRD) by Ethnicity

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>White (n=27)</th>
<th>African American (n=41)</th>
<th>Latino (n=13)</th>
<th>Asian (n=21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male, %</td>
<td>67</td>
<td>44</td>
<td>54</td>
<td>43</td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>50.0 (16.2)</td>
<td>50.7 (13.5)</td>
<td>49.2 (17.0)</td>
<td>52.1 (15.7)</td>
</tr>
<tr>
<td>MRD, mean (SD), mm</td>
<td>5.1 (0.8)</td>
<td>4.5 (1.1)</td>
<td>4.4 (0.9)</td>
<td>3.8 (1.1)</td>
</tr>
</tbody>
</table>

Abnormalities of the upper eyelid position are found in a variety of medical, traumatic, and age-related etiologies. The knowledge of normal eyelid measurements is crucial to the diagnosis and treatment of eyelid position abnormalities. Age is known to affect some eyelid measurements, but it is unknown whether any variation is based on ethnicity. Ethnic and sex differences are reported in some eyelid and facial measurements; however, to our knowledge, there are no published data on the variation of MRD. The data collected in this study suggest that ethnicity affects MRD. This is most apparent when comparing whites with Asians. On average, Asians have an MRD that is 1.3 mm less than that in whites. However, we should note that significant variability exists within each ethnic group (Figure 1).

Without knowledge of normal eyelid position measurements it is not possible to evaluate normal vs abnormal eyelid position. Because trauma or metabolic abnormalities can change eyelid position in any patient group, it is important to know the normal position for each patient to achieve the best and most aesthetically pleasing result. The determination of what constitutes the normal position of the eyelid should be individualized to each patient, taking into account not only ethnicity, age, and sex but also other ophthalmic findings, patient expectations, and patient appearance in old photographs.

Aesthetics and physicians have long used the neoclassical facial canons developed by artists during the Renaissance. These rules of facial proportion were the initial guides for surgeons and the ideal to which many people aspired. In more recent years, various craniofacial measurements have been studied and found to vary among different ethnic groups. Facial beauty is still difficult to define, but facial asymmetry and disfigurement have a negative psychosocial effect on patients. Graves disease with ocular involvement is known to decrease a patient’s quality of life and to cause some patients to appear disfigured. An objective and systematic method of evaluation for diagnosis and of preoperative evaluation for patients specific to their sex, age, and ethnicity, when combined with the usual evaluations in an individualized approach, can achieve an optimal aesthetic outcome and potentially improve patient quality of life.

There are limitations and possible confounding factors to our findings. Given MRD measurements showed that only 22% of the variability is due to sex, ethnicity, and/or age, there may be other variables that were not taken into account. Measurement errors by the examiner are possible, but consistent and reproducible measurements have been seen in previous studies, including measurements taken by different clinicians. Measurement errors could
have occurred if there was any deviation of the patient's eyes to the left or right in the horizontal plane, artificially increasing fissure height measurements. Palpebral fissure height measurements could have been altered by the time of day measurements were taken because palpebral fissure height measurements could have been altered by the ground exists, which can influence body and facial measurements.13

Although our study did not have large sample sizes or cover the spectrum of ethnicities, it suggests that variation in ethnic group studied, and the ethnic groups were broadly generalized and may differ within subpopulations. Among whites, for example, significant variation in ethnic background exists, which can influence body and facial measurements.

Although our study did not have large sample sizes or cover the spectrum of ethnicities, it suggests that variability in MRD measurements will be found across ethnic groups. The coefficients (Table 2) can be used to predict MRD for a new patient with known ethnicity. A study that includes more patients, greater ethnic diversity, and specific subgroups of Asian populations would give additional information on any potential variations in MRD measurements, which could be helpful when individualizing therapeutic options for patients.

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Table 2. Parameter Estimates

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Estimate (SE)</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>5.76 (0.38)</td>
<td>5.02 to 6.49</td>
</tr>
<tr>
<td>Female</td>
<td>0.15 (0.19)</td>
<td>-0.23 to 0.53</td>
</tr>
<tr>
<td>African American</td>
<td>-0.59 (0.24)</td>
<td>-1.06 to -0.12</td>
</tr>
<tr>
<td>Latino</td>
<td>-0.74 (0.32)</td>
<td>-1.37 to -0.11</td>
</tr>
<tr>
<td>Asian</td>
<td>-1.29 (0.28)</td>
<td>-1.84 to -0.74</td>
</tr>
<tr>
<td>Age</td>
<td>-0.01 (0.01)</td>
<td>-0.03 to 0.00</td>
</tr>
</tbody>
</table>

For the multivariate analysis, R² = 0.22.

REFERENCES