Racial Differences in the Association between Optic Disc Topography and Early Glaucoma

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Purpose. To determine the structural characteristics of the optic disc that are associated with early glaucoma in African Americans and whites and whether these characteristics differ between the races.

Methods. Parameters of optic disc topography from 260 African American eyes and 193 white eyes were included in the analysis. One hundred forty-four eyes of African Americans and 109 eyes of normal white subjects were used as a control group. Logistic regression was used to calculate the association between early glaucoma, defined by the visual field, and cup, rim, and disc margin confocal scanning laser ophthalmoscopic (CSLO) parameters, using odds ratios at binary cut points. The cup, rim, and disc margin parameters identified as being independently associated with glaucoma in these reduced models were then included in a single multivariate model. Optic disc area was included in the analysis at each level of the model. This approach was used for the total study group and then separately for the African American and white groups.

Results. When accounting for difference in optic disc area, rim area had the highest independent association with early glaucoma in both groups, but this association was lower in African Americans (odds ratio [95% confidence interval]: 1.63 [1.12–2.36]) than in whites (odds ratio: 4.74 [2.18–10.28]). Additional independently associated parameters included cup shape, maximum elevation along the contour line, and the temporal-to-inferior contour line modulation ratio in whites and cup shape and the temporal-to-superior contour line modulation ratio in African Americans.

Conclusions. Structural characteristics of the optic disc that are best associated with early glaucoma included cup shape and rim area in both groups, but with a less pronounced association in African Americans. In addition, several other race-specific parameters that were independently associated with early glaucoma differed significantly between African Americans and whites. These race-specific differences were independent from the effect of optic disc area. (*Invest Ophthalmol Vis Sci.* 2003;44:3382–3387) DOI:10.1167/iovs.02-0792

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Confocal scanning laser ophthalmoscopy (CSLO) was developed to acquire quantitative topographic information regarding optic disc structure to improve the ability to detect glaucoma and progressive glaucomatous damage. Current studies using the CSLO have been performed in predominantly white study populations[1–9] and have not included adequate numbers of African American subjects to evaluate the role of quantitative optic disc analysis, the parameters that are most predictive of glaucoma, and optimum analysis strategies for detection of glaucoma in this high-risk population. Open-angle glaucoma is more common, more refractory to treatments, and more severe, with higher rates of blindness in African Americans.[10–13]

Several clinical and histologic studies have characterized racial differences in optic disc structure, including larger disc and cup area and lower rim-to-disc area ratio.[14–18] These differences in optic disc structure may have an effect on the ability of CSLO techniques to detect glaucoma. Broadway et al.[19] demonstrated that the discriminating ability of the CSLO varied depending on the phenotype of optic disc damage present. In addition, Iester et al.[20] demonstrated that optic disc area has an effect on the diagnostic precision of the CSLO. This is an important consideration, in that one of the reported differences in optic disc structure between African Americans and whites is disc area.[15] It is imperative that we evaluate methods of disc analysis in African Americans if these instruments are to be applied to this high-risk minority population, both for potential improvement of clinical management and for use as structural end points in clinical trials. The purpose of this study was to determine the structural characteristics of the optic disc that are associated with early glaucoma in African Americans and whites and whether these characteristics differ between the races.

Methods

Subjects

Patients with glaucoma and normal control subjects were recruited from the University of Alabama at Birmingham (UAB) Optic Disc Imaging Center's glaucoma database consisting of patients with glaucoma and normal subjects who had undergone optic disc imaging and visual functional testing between 1999 and 2002 as part of a longitudinal glaucoma study. Only patients whose optic disc images were judged to be of good quality by an experienced operator (JDO), as well as by the retina tomograph software (Heidelberg Retina Tomograph [HRT II], Heidelberg Engineering, Heidelberg, Germany), were included. Data from 116 eyes of 86 African American patients and 84 eyes of 63 white patients with glaucoma in one or both eyes were included in the analysis. One hundred forty-four eyes of 84 African American normal subjects and 109 eyes of 68 white normal subjects were used as the control group. Racial group assignments were determined by the participants' self-description.

All subjects had a complete ophthalmic examination including slit lamp biomicroscopy, intraocular pressure (IOP) measurement, stereoscopic fundus examination, simultaneous stereoscopic photographs of both optic discs, bilateral standard (white-on-white) full threshold

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visual field test (Humphrey Field Analyzer II; Zeiss-Humphrey Systems, Dublin, CA), and bilateral CSLO imaging. All visual field testing and CSLO imaging were completed within 3 months. Informed consent was obtained from all participants, and the University of Alabama at Birmingham Human Subjects Committee approved all methodology. All aspects of the protocol adhered to the tenets of the Declaration of Helsinki.

Patients with glaucoma who enrolled in the study were recruited from the UAB glaucoma clinics and were defined by visual field characteristics alone to avoid bias in the study population by including patients also based on subjective abnormalities of the optic disc. Glaucomatous visual field loss was defined as a corrected pattern standard deviation outside the 95% normal limits or a glaucoma hemifield test results outside the 99% normal limits, which was confirmed on follow-up examination. Subjects with severe glaucoma (mean deviation [MD] >15) were excluded. Patients with a best corrected visual acuity of worse than 20/40, visually significant cataracts (nuclear sclerotic cataracts with visual acuity worse than 20/40 or posterior subcapsular cataract), spherical refraction outside ±5.0, or cylinder correction outside ±2.5, comorbid neurologic or ophthalmic conditions, or use of medication known to affect visual sensitivity at the time of visual field testing were excluded.

Normal subjects were recruited into the study and had a highest documented IOP of 22 mm Hg or less, normal visual field results defined as a corrected pattern standard deviation within the 95% normal limits, and glaucoma hemifield test results within normal limits. Patients with best corrected visual acuity of worse than 20/40, a family history of glaucoma, spherical refraction outside ±5.0, or cylinder correction outside ±2.5 were excluded. Patients using medications known to affect visual sensitivity at the time of visual field testing and those with ophthalmic or neurologic surgery or disease also were excluded.

Visual field testing used the 24-2 Swedish Interactive Thresholding Algorithm (SITA) testing strategy (Zeiss-Humphrey Systems). SITA perimetry is an automated perimetric technique using a standard white-on-white stimulus on the Humphrey Field Analyzer II (Zeiss-Humphrey Systems), which has been commercially available since 1997.[21] It differs from conventional full-threshold techniques in the method of threshold determination. The SITA algorithm uses visual field modeling and informational indexing to arrive at a threshold value more rapidly. In addition, SITA reduces testing time by test pacing, posttest recomputation of threshold values, and using inferential calculation to determine reliability indices. Whereas most previous evaluations of CSLO have been performed with full-threshold standard perimetry, full-threshold SITA correlates well with standard perimetry,[22,23] has lower inter- and intratest variability than standard full-threshold perimetry,[24,25] and reduces testing time and subject fatigue.[21]

The CSLO (HRT II) provides topographic measurements of the optic nerve and peripapillary retina. The HRT II confocal scanning laser ophthalmoscope uses a diode laser (670 nm wavelength) to produce three-dimensional measurements of optic disc topography based on reflectance from the retinal and optic disc surface. The HRT II is a modified version of the original HRT designed specifically for imaging of the optic disc. Unlike its predecessor, the HRT II takes three consecutive scans per scanning session and averages them together automatically. An image series is obtained from 16 to 64 transverse optical section images taken at consecutive 62-μm depth intervals over a scan depth of 1 to 4 mm. The scan depth and number of imaging planes are determined from a prescan of the optic disc to ensure that the entire optic disc is included in the image. The topography image determined from the acquired three-dimensional image consists of 384 × 384 × 16 to 384 × 384 × 64 voxel elements.

Image acquisition takes approximately 1.5 seconds per series. The instrument automatically obtains three 15° images of one eye in sequence per imaging session. A mean topography image adjusted for alignment and rotation is created automatically with existing software and was used for all analyses in the present study. Correction for magnification was determined based on keratometry readings. Although pupil dilation is often not required, all eyes were imaged after full dilation. An experienced operator evaluated image quality and outlined the disc margin while viewing stereoscopic photographs of the optic disc. Only good-quality images (based on subjective assessment by the operator and objective criteria, such as a standard deviation of the mean topography image less than 40 μm were used in analyses.

The HRT II includes a comprehensive software package that facilitates image acquisition, storage, retrieval, and quantitative analysis. Software-determined parameters are retinal nerve fiber layer (RNFL) thickness, RNFL cross-sectional area, rim area, and volume, mean height contour, cup volume, cup shape, mean cup depth, maximum cup depth, cup area, optic disc area, and cup-to-disc area ratio. RNFL thickness, RNFL cross-section area, rim volume, rim area, cup volume, and cup area are measured relative to a standard reference plane. The position of the standard reference plane is 50 μm posterior to the mean height of the optic disc margin contour line in a temporal segment between 350° and 356°.

Statistical Analysis

The goal of this study was to evaluate the association between glaucoma and optic disc structural parameters and to determine whether these associations differ between African Americans and whites. Structural parameters describing the cup were vertical cup-to-disc ratio, cup volume and area, cup shape, and the mean and maximum depth of the cup. Structural parameters describing the neuroretinal rim were rim volume, global rim-to-disc ratio, and rim area. Disc margin parameters included in the model were RNFL thickness, contour line modulation (CLM) ratios for the inferior-to-temporal and superior-to-temporal sectors, and the maximum elevation and depression of the contour line.

Logistic regression was used to calculate the association between glaucoma and cup, rim, and disc margin parameters using odds ratios and 95% confidence intervals. Before including structural parameters in the logistic regression models, the distributions of each of these normally continuous variables were evaluated for the total study population, and the median value was used to categorize each variable. To determine the set of structural parameters that demonstrated significant, independent associations with glaucoma, several logistic regression models were evaluated. First, the association between glaucoma and each structural parameter was estimated separately. Then, a multivariate model was estimated that included all cup structural parame-

Table 1. Demographic Data

	Glaucoma			Controls		
	African American	White	*P*	African American	White	*P*
Eyes (*n*)	116	84		144	109	
Mean age (y)	57.7	60.3	.1879	45.5	46.2	.6659
Gender (% female)	67.2	52.4	.0335	79.2	66.1	.0193
Highest IOP (mm Hg)	19.8 ± 5.1	19.1 ± 4.6	.313	16.5 ± 3.4	16.7 ± 3.1	.7438
MD (dB)	4.7 ± 3.5	4.4 ± 3.6	.6086	.34 ± .91	.21 ± .69	.8016

TABLE 2. Comparison of CLSO Optic Disc Parameters in Normal Study Eyes

	African-American	White	*P*
Eyes (*n*)	144	109	
Disc area (mm^2)	2.26 (0.45)	1.98 (0.38)	<0.0001
Cup area (mm^2)	0.63 (0.39)	0.44 (0.36)	<0.0001
Cup volume (mm^3)	0.16 (0.14)	0.09 (0.13)	<0.0001
Rim area (mm^2)	1.62 (0.30)	1.54 (0.36)	0.0435
Rim volume (mm^3)	0.47 (0.16)	0.44 (0.19)	0.1257
Cup shape	−0.17 (0.08)	−0.18 (0.07)	0.4007
Global rim-to-disc ratio	0.62 (0.21)	0.68 (0.23)	0.0355
Mean cup depth (mm)	0.30 (0.19)	0.24 (0.14)	0.0010
Reference plane (mm)	0.35 (0.12)	0.36 (0.13)	0.9860
RNFL thickness (mm)	0.29 (0.06)	0.26 (0.09)	0.0382
Maximum contour line elevation (mm)	−0.06 (0.13)	−0.08 (0.12)	0.0374
Maximum contour line depression (mm)	−0.11 (0.12)	−0.13 (0.10)	0.0374
CLM temporal–superior	0.33 (0.14)	0.28 (0.14)	0.2417
CLM temporal–inferior	0.24 (0.08)	0.20 (0.09)	0.4065

Data are expressed as the mean, with the standard deviation in parentheses.

ters in a single model that were independently significant; similar models were evaluated for rim and disc margin parameters. From these three separate full models, only those variables that demonstrated significant, independent associations in each model were retained in reduced models. Finally, the cup, rim, and disc margin parameters identified as being independently associated with glaucoma in these reduced models were then included in a single multivariate model. In the context of this model, only those variables that retained statistical significance were maintained in the final model. To account for the effect of differences in optic disc area, this parameter was included in the multivariate model at each level of interaction in constructing the final model. Thus, the final model is composed of the parameters with the best independent associations with glaucoma, independent of the effect of disc area. This approach was used for the total study sample, and then separately for African Americans and whites. Finally, to account for the intercorrelation of eyes within persons, generalized estimating equations were used for these calculations.

The use of median cut points that ignore disease and race-specific distributions has both advantages and disadvantages. With respect to the former, this approach provides a set of variables that can be readily compared across groups. If different cut points had been chosen for specific groups, between-group comparisons (e.g., blacks versus whites) would be impaired. With respect to disadvantages, the use of a median cut point may hide or exaggerate the true association. Unfortunately, when the sample size is small, as in this study, the creation of tertiles or higher order cut points is difficult. Thus, evaluating the actual nature of the association beyond binary variables is problematic. Ultimately, when the true nature of the relationships is not known and sample size is limited, the use of arbitrary cut points, as in this study, reflects a conservative approach.

RESULTS

Demographic characteristics for the normal control and glaucoma groups are shown in Table 1. There were no significant differences in age, highest measured intraocular pressure, or mean defect in the visual field between African Americans and whites in the normal control or glaucoma group. Female gender was more common in the African American group. Optic disc parameters from the CSLO obtained from the control group are illustrated in Table 2. Several parameters differ significantly between racial groups. Similar to prior reports,[14–17] disc area, rim area, and cup area were larger and rim-to-disc area ratio was smaller in the African American group.

CSLO parameters for normal and glaucomatous eyes are shown for the African American and white groups in Table 3. In whites and in African Americans, all tested CSLO parameters

TABLE 3. Comparison of CLSO Optic Disc Parameters between Glaucomatous and Normal Control Eyes for African-Americans and Whites

	African American			White		
	Glaucoma	Normal	*P*	Glaucoma	Normal	*P*
Eyes (*n*)	116	144		84	109	
Disc area (mm^2)	2.45 (0.60)	2.26 (0.45)	0.0040	2.24 (0.40)	1.98 (0.38)	<0.0001
Reference plane (mm)	0.38 (0.12)	0.36 (0.12)	0.111	0.38 (0.18)	0.35 (0.13)	0.330
Cup area (mm^2)	1.18 (0.56)	0.63 (0.39)	<0.0001	1.06 (0.38)	0.44 (0.36)	<0.0001
Cup volume (mm^3)	0.37 (0.28)	0.16 (0.14)	<0.0001	0.31 (0.24)	0.09 (0.13)	<0.0001
Rim area (mm^2)	1.27 (0.41)	1.62 (0.30)	<0.0001	1.18 (0.36)	1.54 (0.36)	<0.0001
Rim volume (mm^3)	0.28 (0.13)	0.47 (0.16)	<0.0001	0.25 (0.14)	0.44 (0.19)	<0.0001
Cup shape	−0.09 (0.08)	−0.17 (0.08)	<0.0001	−0.10 (0.06)	−0.18 (0.07)	<0.0001
Rim-to-disc ratio	0.27 (0.15)	0.62 (0.21)	<0.0001	0.25 (0.12)	0.68 (0.23)	<0.0001
Mean cup depth (mm)	0.36 (0.16)	0.30 (0.19)	0.003	0.33 (0.15)	0.24 (0.14)	0.005
RNFL thickness (mm)	0.19 (0.07)	0.29 (0.06)	<0.0001	0.17 (0.08)	0.26 (0.09)	<0.0001
Maximum contour line elevation (mm)	0.01 (0.11)	−0.13 (0.12)	<0.0001	−0.02 (0.12)	−0.13 (0.10)	<0.0001
Maximum contour line depression (mm)	0.38 (0.14)	0.33 (0.14)	0.0027	0.34 (0.15)	0.28 (0.14)	0.0045
CLM temporal–superior	0.15 (0.10)	0.24 (0.08)	<0.0001	0.14 (0.09)	0.20 (0.09)	<0.0001
CLM temporal–inferior	0.11 (0.10)	0.21 (0.08)	<0.0001	0.09 (0.11)	0.20 (0.10)	<0.0001

Data are expressed as the mean, with the standard deviation in parentheses.

TABLE 4. Multivariate Logistic Regression Models for the Overall Group

	Model 1	Model 2	Model 3
Cup-related parameters			
Area >0.75	2.52 (1.73–3.67)	1.70 (1.06–2.73)	2.04 (1.31–3.19)
Volume >0.166	2.14 (1.46–3.15)	1.30 (0.79–2.14)	
Shape >−0.139	1.95 (1.50–2.52)	1.78 (1.36–2.33)	1.97 (1.48–2.62)
Depth >0.256	1.37 (1.05–1.78)	0.81 (0.60–1.09)	
Vertical cup-to-disc ratio >0.538	2.01 (1.53–2.64)	1.51 (1.14–1.99)	1.44 (1.04–1.98)
Rim-related parameters			
Area >1.412	2.88 (2.06–4.02)	1.11 (0.99–1.24)	
Volume >0.353	2.82 (1.19–3.63)	1.05 (0.99–1.12)	
Rim-to-disc area ratio >0.588	1.16 (1.02–1.32)	0.97 (0.86–1.10)	
Disc margin parameters			
RNFL Thickness >0.235	1.38 (1.06–1.79)	1.16 (0.90–1.49)	
Maximum elevation >−0.05	1.70 (1.29–2.24)	1.86 (1.38–2.51)	1.74 (1.26–2.41)
Maximum depression > 0.332	1.17 (0.99–1.40)		
CLM temporal–superior > 0.188	1.32 (1.09–1.59)	1.27 (1.03–1.58)	1.52 (1.16–1.98)
CLM temporal–inferior > 0.163	1.40 (1.08–1.83)	1.36 (1.06–1.75)	1.99 (1.46–2.74)

Model 1 contains the univariate odds ratios adjusted for disc area. Model 2 contains odds ratios adjusted for the group and disc area interactions. Model 3, contains those parameters that remain significant when all interaction are taken into account. Numbers in the left column represent median cutoffs.

Data are odds ratios, with 95% CIs in parentheses.

were significantly different ($P < 0.05$) between the glaucoma and normal groups. However, significant overlap existed between diagnostic groups for all parameters, similar to previous reports in whites. There were no significant differences in reference plane height between African Americans and whites, with or without glaucoma.

Tables 4, 5, and 6 present the adjusted odds ratios for the association between optic disc parameters and glaucoma for all, African American, and white subjects, respectively. Model 1 contains the univariate odds ratios adjusted for disc area. Model 2 contains odds ratios adjusted for the group and disc area interactions, and the final model, Model 3, contains those parameters that remain significant when all interactions are taken into account. To determine whether our selection of parameter groupings into cup, rim, and disc margin parameters affected the selection of the associated parameters that surfaced in each group, we reran the model using all the parameters together in a single group and found no difference in the parameters that best predicted glaucoma in whites, African Americans, or the total group.

In the total group, cup area, cup shape, vertical cup-to-disc ratio, maximum elevation, and both CLM ratios where significantly independently associated with early glaucoma. In the white group, rim area provided the highest odds ratio of the independently associated parameters (odds ratio [OR]: 4.74, 95% confidence interval [CI]: 2.18–10.28), followed by the maximum elevation along the contour line (odds ratio: 3.41, 95% CI: 1.78–6.51), cup shape (OR: 3.31, 95% CI: 1.75–5.62), and the CLM temporal–inferior (OR: 2.69, 95% CI: 1.20–6.02). In the African American group, rim area provided the highest odds ratio (OR: 1.63, 95% CI: 1.12–2.36), followed by CLM temporal–superior (OR: 1.34, 95% CI: 1.06–1.69), and cup shape (OR: 1.27, 95% CI: 1.01–1.59). The odds ratio for the independently associated parameters for African Americans and whites are presented for comparison in Figure 1.

Figure 2 presents the odds ratios for whites and African Americans based on the number of significant independently associated parameters that were in common with each final race-specific models: cup shape and rim area. These summary odds ratios were all higher in whites and significantly higher when these two combined risk factors were present. Whites with one risk factor present (either rim area or cup shape) had an odds ratio of 4.56 (95% CI: 2.16–9.37) increasing to 15.40 (95% CI: 6.70–35.39) with both risk factors. In the African

TABLE 5. Multivariate Logistic Regression Models for the African Americans

	Model 1	Model 2	Model 3
Cup-related parameters			
Area > 0.75	1.95 (1.23–3.07)	1.22 (0.97–1.54)	
Volume > 0.166	1.61 (1.03–2.51)	1.14 (0.86–1.50)	
Shape >−0.139	1.63 (1.17–2.26)	1.30 (1.05–1.61)	1.27 (1.01–1.59)
Depth > 0.256	1.39 (0.90–2.16)		
Vertical cup-to-disc ratio > 0.538	1.65 (1.15–2.38)	1.27 (1.03–1.57)	
Rim-related parameters			
Area > 1.412	2.18 (1.35–3.53)	2.01 (1.16–3.47)	1.63 (1.12–2.36)
Volume > 0.353	1.90 (1.50–2.41)	1.26 (0.99–1.61)	
Rim-to-disc area ratio > 0.588	1.00 (0.99–1.01)		
Disc margin parameters			
RNFL thickness > 0.235	1.25 (0.91–1.72)		
Max elevation >−0.05	1.47 (0.99–2.19)		
Max depression > 0.332	1.25 (0.92–1.68)		
CLM temporal–superior > 0.188	1.36 (1.10–1.68)	1.36 (1.10–1.68)	1.34 (1.06–1.69)
CLM temporal–inferior > 0.163	1.25 (0.88–1.78)		

Data and models are as described in Table 4.

TABLE 6. Multivariate Logistic Regression Models for the Whites

	Model 1	Model 2	Model 3
Cup-related parameters			
Area > 0.75	3.49 (1.85–6.57)	2.56 (0.98–6.72)	
Volume > 0.166	3.69 (1.79–7.60)	1.51 (0.46–4.98)	
Shape >−0.139	2.43 (1.59–3.72)	2.50 (1.43–4.38)	3.13 (1.75–5.62)
Depth > 0.256	1.45 (1.06–1.99)	0.87 (0.39–1.92)	
Vertical cup-to-disc ratio > 0.538	3.30 (1.97–5.51)	1.95 (1.01–3.79)	
Rim-related parameters			
Area > 1.412	4.52 (2.38–8.57)	2.70 (1.50–4.86)	4.74 (2.18–10.28)
Volume > 0.353	4.37 (2.50–7.63)	2.70 (1.59–4.58)	
Rim-to-disc area ratio > 0.588	0.99 (0.76–1.30)		
Disc margin parameters			
RNFL thickness > 0.235	1.40 (0.90–2.20)		
Max elevation >−0.05	2.58 (1.62–4.11)	3.80 (2.14–6.73)	3.41 (1.78–6.51)
Max depression > 0.332	1.08 (0.89–1.31)		
CLM temporal–superior > 0.188	1.16 (0.83–1.61)		
CLM temporal–inferior > 0.163	1.67 (1.11–2.51)	2.33 (1.32–4.11)	2.69 (1.20–6.02)

Data and models are as described in Table 4.

American group, one risk factor conveyed an odds ratio of 1.45 (95% CI: 0.96–2.18) and 1.92 (95% CI: 1.35–2.73) when both risk factors were present.

DISCUSSION

The results of our study indicate that racial differences exist in optic disc structural parameters that are independently predictive of early glaucoma between African Americans and whites, even when accounting for differences in optic disc area. Although the most predictive parameter, rim area, was the same in each racial group, the magnitude of association was higher in whites. Differences in disc area account for some of these racial differences; however, residual differences still persist. Overall, the summary odds ratios based on the most predictive CSLO parameters demonstrated a lower association with glaucoma in African Americans, even when adjusted for the effect of disc area.

Several clinical and histologic studies have characterized racial differences in optic disc structure between African Americans and whites. Quantitative evaluation of conventional optic disc photography from the Baltimore Eye Survey demonstrated that mean optic disc area was 12% larger in the African American population.[14] Cup area was increased as well. Although global rim area was similar in both racial groups, because of the relatively larger optic disc in African Americans, there was a decrease in rim-to-disc area ratio, indicating that there may be a decrease in rim thickness and nerve fibers relative to disc size in this population. In a smaller study including 200 normal subjects, also using disc photography, Beck et al.[15] also demonstrated that there was an increase in cup-to-disc ratio in African Americans relative to whites. Chi et al.[16] examined 30 whites and 31 African Americans without any ocular disease, using the Rodenstock optic nerve analyzer (Rodenstock Precision Optics, Rockford, IL), and also found a relative increase in cup-to-disc ratio among African Americans. Finally, a postmortem histologic study of 30 whites and 30 African Americans demonstrated an increase in the vertical diameter of the optic disc, but not in horizontal diameter in the African American population.[17]

Our study found additional racial differences in our normal control subjects with CSLO than have previous studies using photography and other quantitative methods, including larger disc area, cup-to-disc ratio, rim area, and cup area in African

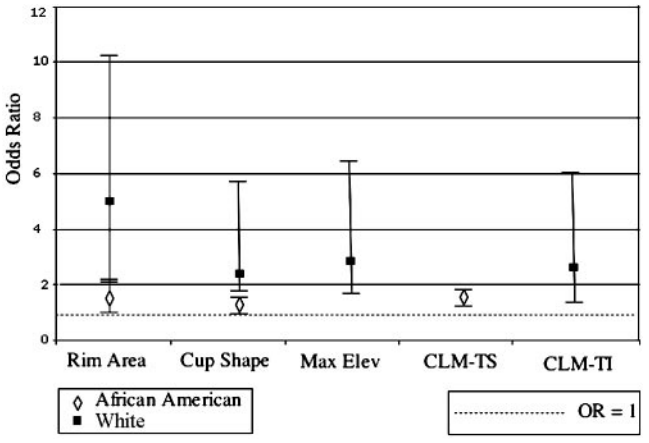

FIGURE 1. The odds ratios and 95% confidence intervals for the significant parameters in the final race-specific models for African Americans and whites, provided for comparison. Max Elev, maximum elevation along the contour line; CLM-TS, CLM ratio (temporal-to-superior); CLM-TI, CLM ratio (temporal-to-inferior).

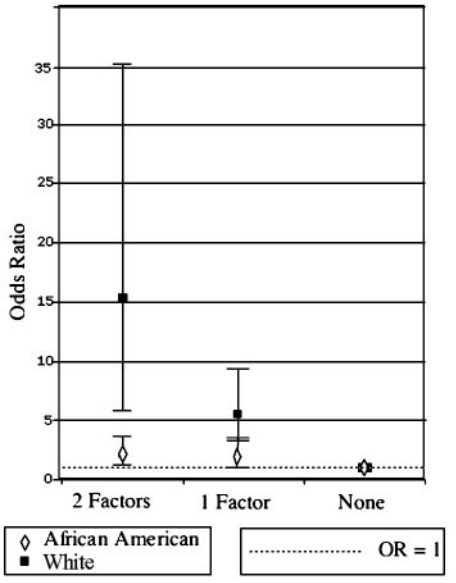

FIGURE 2. Summary odds ratios and 95% confidence intervals when 1 and 2 risk factors are present.

Americans, and we found several other CSLO parameters that were significantly different in the African American control group, including greater cup depth and a thicker nerve fiber layer.

Most of the previous case–control studies involving glaucoma detection and the CSLO have provided measures of sensitivity and specificity.[1–9] Although these studies have provided an assessment of the association between individual CSLO parameters and glaucoma, they have not evaluated which parameters demonstrate independent associations. Thus, the purpose of this study was to identify and quantify the topographic characteristics independently associated with early glaucoma that differed between these racial groups, which may help indicate their risk of development of early glaucomatous damage. In both groups, cup shape and rim area were significantly associated independent parameters, although these parameters had a significantly lower association in the African-American group. There were significant differences in several other parameters as well (Fig. 1).

In summary, our study has demonstrated that structural characteristics of the optic disc that are most associated with glaucoma differ between African Americans and whites, independent of differences in disc area. Higher odds ratios were found in models combining two parameters than in models based on a single parameter. In addition, two-parameter models had significantly higher odds ratios in whites than in African-Americans. These differences in the relationship between optic disc structural and visual functional measures between African Americans and whites indicate that topographic features of the optic disc convey different information with regard to assessing the risk of early glaucoma in African Americans, which should be considered in the statistical judgment of disease status based on these parameters.

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