
Central corneal thickness and intraocular pressure in Puerto Rican glaucoma patients

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Objective: To compare the variations in central corneal thickness and intraocular pressure measurements according to race, gender, and age.

Methods: A non-concurrent prospective study of 372 (744 eyes) glaucoma patients was conducted. Central corneal thickness was measured with ultrasound pachymeter and intraocular pressure with Goldmann tonometer. The relationship between CCT, race, gender, and age was evaluated using both descriptive and statistical analysis.

Results: The population age was 64 ± 19.52 years. The mean central corneal thickness was 546 ± 43.84 μm . The mean corrected intraocular pressure was 17 ± 5.26 mm Hg. Central corneal thickness of male patients (549 ± 43.43 μm) was thicker than that of female patients (546 ± 41.83 μm). The mean corrected intraocular pressure in male patients (16 ± 5.41 mm Hg) was less than that of female patients (17 ± 5.18 mm Hg). The mean central corneal thickness in patients 0 to 9 years-

of-age was 548 ± 36.08 μm ; 10 to 19 years-of-age was 606 ± 82.30 μm ; 20 to 29 years-of-age was 564 ± 29.23 μm ; 30 to 39 years-of-age was 579 ± 15.32 μm ; 40 to 49 years-of-age was 546 ± 48.29 μm ; 50 to 59 years-of-age was 550 ± 38.12 μm ; 60 to 69 years-of-age was 545 ± 40.22 μm ; 70 to 79 years-of-age was 541 ± 34.71 μm ; 80 to 89 years-of-age was 541 ± 34.05 μm ; older than 90 years-of-age was 527 ± 46.90 μm .

Conclusions: Central corneal thickness of glaucoma patients in Puerto Rico was similar to that of Hispanics in the continental United States. However, the intraocular pressure and corrected intraocular pressure of glaucoma patients in Puerto Rico were statistically higher than that of Hispanics with glaucoma in the continental United States. In our study population, central corneal thickness and intraocular pressure were not affected by gender or age.

Key words: Glaucoma, Central corneal thickness, CCT, Pachymetry

Previous studies have shown that intraocular pressure (IOP), as measured by the Goldmann tonometer, needs to be corrected according to central corneal thickness (CCT) values in order to obtain a better IOP estimate (1-8). Since IOP remains the most important risk factor leading to glaucoma, (9) CCT measurements are of utmost importance in the evaluation of patients with glaucoma (10).

Varma and co-workers (11) have suggested that Latinos have a higher prevalence of glaucoma than Caucasians living in the continental United States (US). Glaucoma remains the leading cause of bilateral blindness among

Latinos (12) Further, the prevalence of glaucoma in Latinos increases proportionally with increasing age (13).

Results from Los Angeles Latino Eye Study Group (LALES) (10) show that CCT in Latinos is thinner than that of Caucasians but thicker than that of African Americans. We report on the CCT and IOP of Latinos with glaucoma living in Puerto Rico and compare it with that of Hispanics living in the continental US.

Patients and Methods

We conducted a non-concurrent prospective study of 372 patients with glaucoma (all types included). These patients underwent a comprehensive eye exam in the San Juan metropolitan area from May to December 2005. There were 120 male and 252 female patients. Goldmann applanation tonometry (GAT) was used to measure IOP. CCT was measured with the PachPen Hanheld® ultrasound pachymeter. GAT IOP values were corrected according to the correction factors suggested by the PachPen Hanheld®

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ultrasound pachymeter user manual, based on studies by done by Doughty and Zaman (14).

The relationship between CCT, race, gender, and age was evaluated using both descriptive and statistical analysis. For this purpose, the patients from this study were categorized into age groups in order to analyze the correlation of age and CCT. IOPs were grouped into ranges in order to analyze the correlation of IOP with CCT. Student t tests were used to evaluate differences in CCT and IOP according to race, gender, and age.

Results

The mean (\pm standard deviation) age of the population was 64 ± 19.52 years-of-age. The demographical breakdown by age and gender are depicted in Table 1.

IOP measured by GAT ranged from 4 to 50 mm Hg

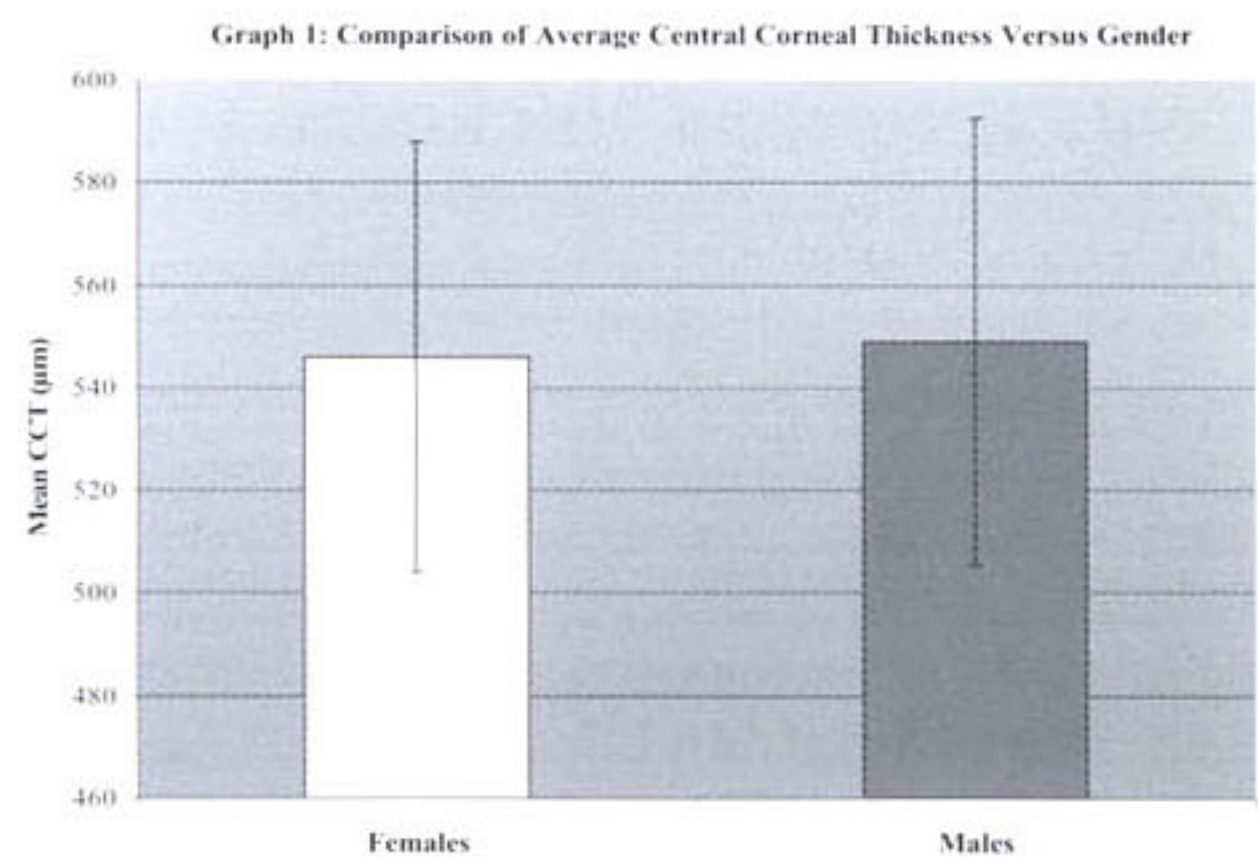
Table 1. Characteristics of Study Population

	n (%)
All patients	372 (100)
Gender	
Female	252 (67.7)
Male	120 (32.3)
Age	
0-9	11 (2.76)
10-19	16 (4.30)
20-29	7 (1.88)
30-39	1 (1.08)
40-49	21 (5.65)
50-59	44 (11.83)
60-69	81 (21.8)
70-79	135 (36.3)
80-89	47 (12.6)
> 90	6 (1.61)

(mean = 17 ± 4.78 mm Hg). CCT of 744 eyes ranged from 444 μ m to 840 μ m. The mean CCT of all participants was 546 ± 43.84 μ m. Correction Factors ranged from -7 to 7 mm Hg (mean = 0 ± 2.72 mm Hg). Corrected IOP ranged from 2 to 49 mm Hg (mean = 17 ± 5.26 mm Hg).

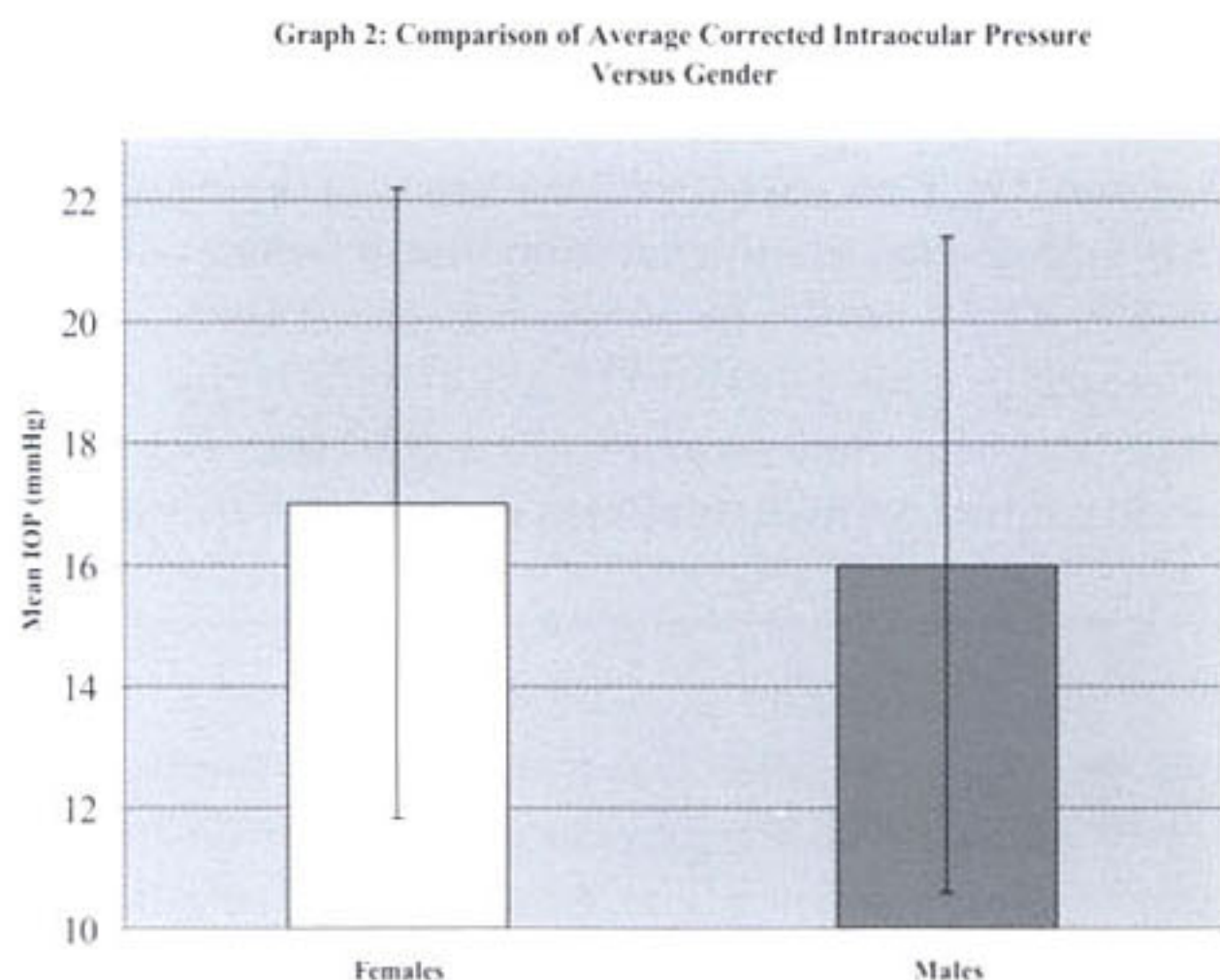
As depicted in Figure 1, CCT of 240 eyes from male patients ranged from 455 μ m to 794 μ m (mean = 549 ± 43.43 μ m). CCT of 504 eyes from female patients ranged from 444 μ m to 840 μ m (mean = 546 ± 41.83 μ m). IOP in male patients ranged from 4 mm Hg to 40 mm Hg (mean = 16 ± 4.73 mm Hg). IOP in female patients ranged from 6 mm Hg to 50 mm Hg (mean = 17 ± 4.80 mm Hg). Correction Factors in male patients ranged from -7 mm Hg to 6 mm Hg (mean = 0 ± 2.79). Correction Factors in female patients ranged from -7 mm Hg to 7 mm Hg (mean = 0 ± 2.69 mm Hg).

Figure 2 shows the mean corrected IOP in male and



female patients. Corrected IOP in male patients ranged from 2 mm Hg to 39 mm Hg (mean = 16 ± 5.41 mm Hg). Corrected IOP in female patients ranged from 4 mm Hg to 49 mm Hg (mean = 17 ± 5.18 mm Hg).

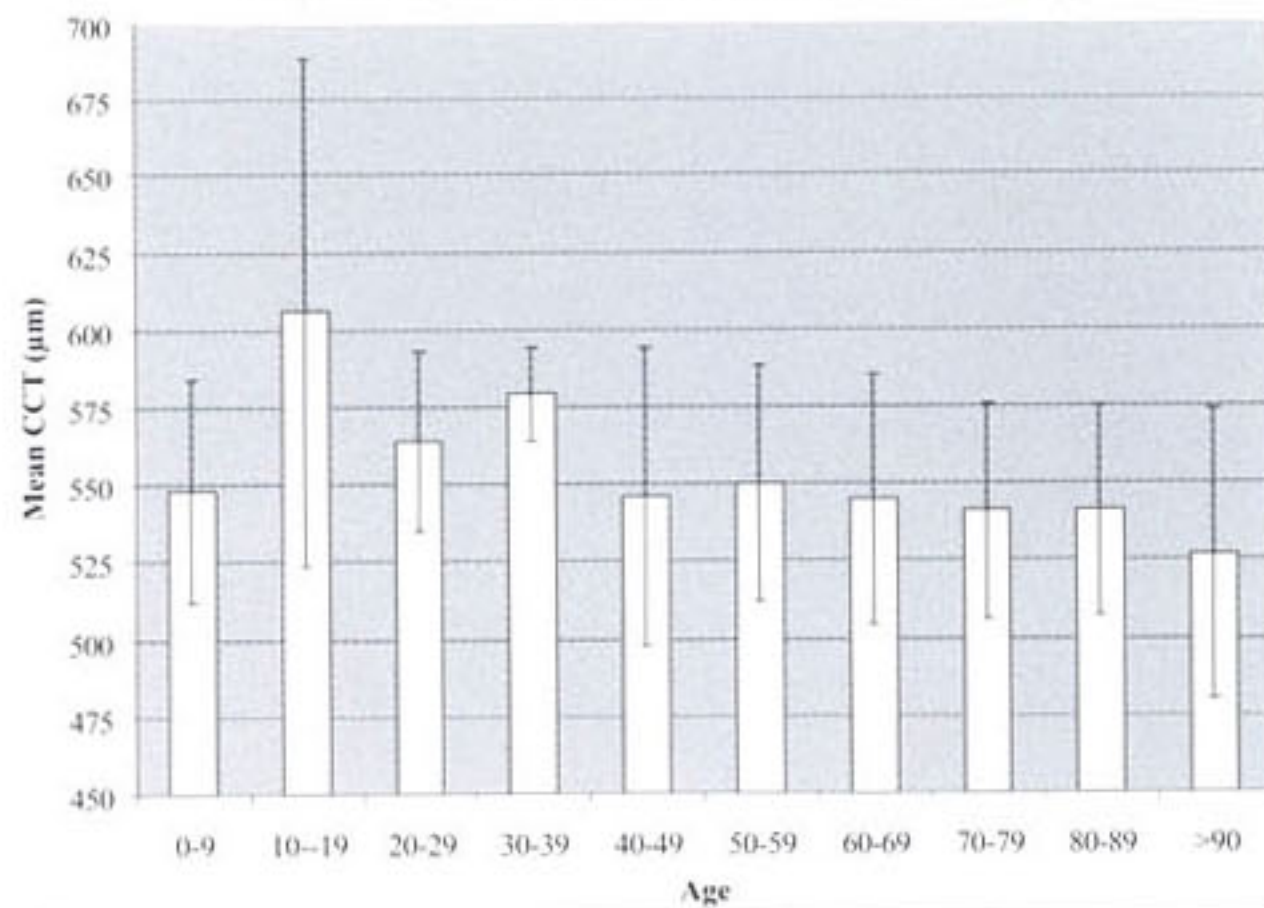
Figure 3 depicts the mean CCT value of Puerto Rican



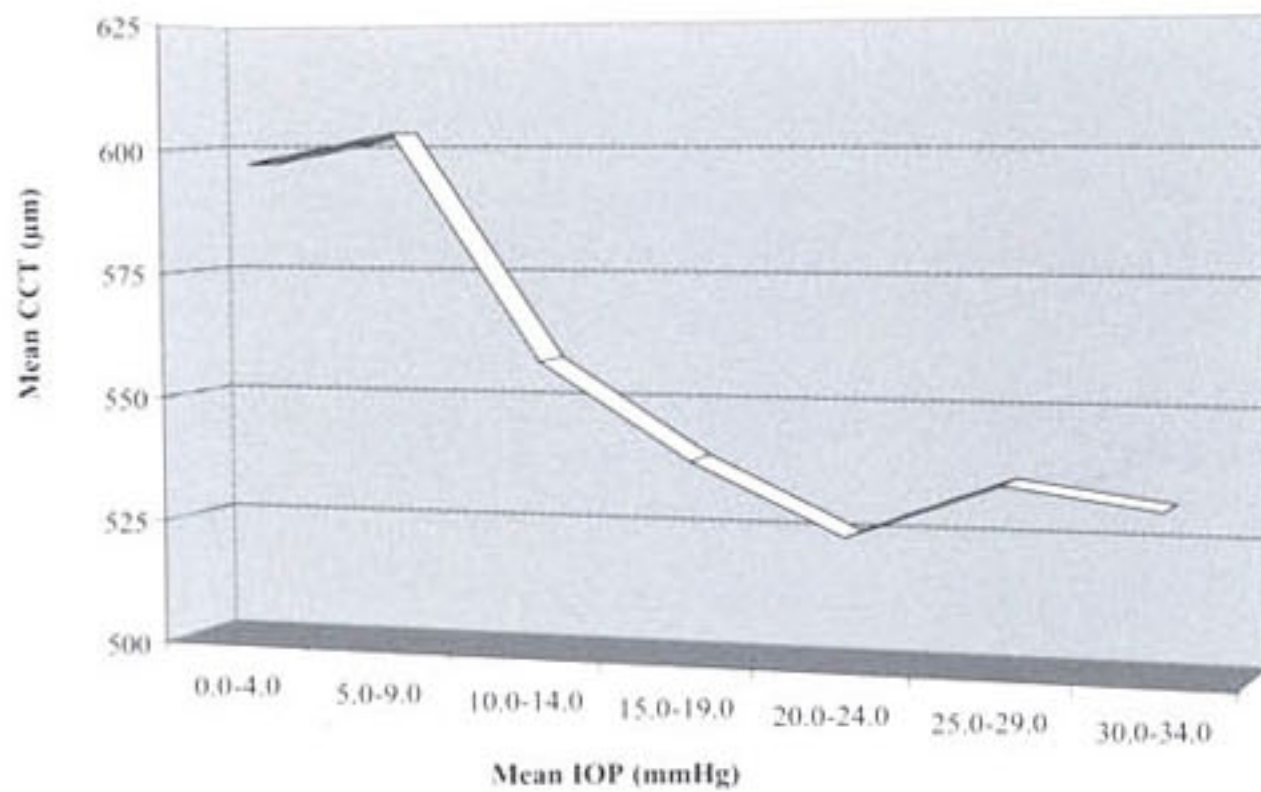
glaucoma patients according to age groups. The mean CCT in patients from 0 to 9 years-of-age was 548 ± 36.08 μ m; from 10 to 19 years-of-age was 606 ± 82.30 μ m, from 20 to 29 years-of-age was 564 ± 29.23 μ m, from 30 to 39 years-of-age was 579 ± 15.32 μ m, from 40 to 49 years-of-age was 546 ± 48.29 μ m, from 50 to 59 years-of-age was 550 ± 38.12 μ m, from 60 to 69 years-of-age was 545 ± 40.22 μ m, from 70 to 79 years-of-age was 541 ± 34.71 μ m, from 80 to 89 years-of-age was 541 ± 34.05 μ m, and for 90 years-of-age and above was 527 ± 46.90 μ m.

Figure 4 shows a correlation of ranges of corrected IOP with the mean CCT values in patients. The mean CCT of patients with a corrected IOP from 0 to 4 mm Hg was 597 μ m; from 5 to 9 mm Hg was 603 μ m; from 10 to 14 mm Hg was 558 μ m; from 15 to 19 mm Hg was 539 μ m; from 20 to 24

Graph 3: Comparison of Central Corneal Thickness Versus Age



Graph 4: Comparison of Central Corneal Thickness Versus Corrected Intraocular Pressure



mm Hg was 525 µm; from 25 to 29 mm Hg was 536 µm; from 30 to 34 mm Hg was 532 µm.

Discussion

To our knowledge, this study is the first report that evaluates the CCT and IOP measurements of the Hispanic population living in Puerto Rico. It compares CCT values of glaucoma patients in Puerto Rico with the CCT values of Hispanics patients with glaucoma living in the continental US. We were particularly interested in evaluating variations in CCT values and IOP measurements according to race, gender, and age. Comparing CCT measurements in glaucoma patients from Puerto Rico to those of Latinos living in the continental US may lead to improved ophthalmic care in the Puerto Rico glaucoma population.

Previous studies (15) suggest that the mean CCT of the general US glaucoma population is $531 \pm 5 \mu\text{m}$. The variation between CCT values in our study and that of the general

US glaucoma population is considered to be extremely statistically significant ($t = 9.6581, P < 0.0001$). Recent studies by La Rosa and co-workers (16) concluded that the mean CCT of African Americans with glaucoma living in the continental US was $528.8 \pm 36.75 \mu\text{m}$. When we compared the mean CCT of our sample with that of African Americans with glaucoma living in the continental US (16) there is a statistically significant difference ($t = 3.9480, P < 0.0001$). Conversely, Caucasians with glaucoma in the continental US have a mean CCT of $561 \pm 37.9 \mu\text{m}$ (16). The difference between the mean CCT of our sample with that of the Caucasian population with glaucoma living in the continental US is considered statistically significant ($t = 2.6529, P = 0.0081$).

On the other hand, Latinos with glaucoma in the continental US have a mean CCT equal to $551.1 \pm 35.54 \mu\text{m}$ (17). The difference between our patients with those patients studied by the LALES is not statistically significant ($t = 1.5261, P = 0.1273$). These findings suggest that the CCT of Latinos with glaucoma in Puerto Rico is similar to that of Latinos with glaucoma living in the continental US. Nonetheless, the CCT of Latinos with glaucoma in Puerto Rico is significantly thicker compared to that of the African Americans and the general population with glaucoma living in the continental US. On the other hand, Caucasians with glaucoma in the continental US have a significantly thicker CCT compared to that of Latinos with glaucoma in Puerto Rico.

Measurement of CCT is essential to a comprehensive ophthalmologic examination of patients with glaucoma. CCT has a significant impact on the accuracy of IOP measurement. Previous studies (17) have suggested that Latinos with glaucoma in the continental US have a mean GAT value of $15.23 \pm 2.3 \text{ mmHg}$. When we compared our sample mean IOP ($17 \pm 4.78 \text{ mmHg}$) with their results there is a statistically significant difference ($t = 3.7667, P = 0.0002$).

Shimmyo and co-workers (17) showed that Latinos with glaucoma in the continental US have a mean corrected IOP of $15.16 \pm 2.66 \text{ mmHg}$. When we compared the mean corrected IOP ($17 \pm 5.26 \text{ mmHg}$) of our sample with the above mentioned study we found the difference to be statistically significant ($t = 3.5040, P = 0.0005$). Hence, both GAT and corrected IOP values are significantly higher in Latinos with glaucoma in Puerto Rico than that of Latinos with glaucoma living in the continental US. This finding suggests that although the CCT of glaucoma patients in Puerto Rico was similar to that of Latinos with glaucoma living in the continental US, the IOP of glaucoma patients in Puerto Rico was significantly higher. This variation needs to be taken into consideration in the diagnosis and treatment of patients with glaucoma in Puerto Rico.

Previous studies (14,16,18-25) have suggested that race,

gender, and age may influence CCT measurements. There are no previous studies that characterize the relationship between gender and CCT in Latinos with glaucoma living in Puerto Rico. Moreover, there is no general consensus on the gender-related differences in CCT in the general US population (10). In our study we found no statistically significant difference between CCT of men and women with glaucoma living in Puerto Rico ($t=0.9032$, $P=0.3667$). We found a statistically significant difference between corrected IOP of men and women with glaucoma living in Puerto Rico ($t=2.4263$, $P=0.0155$).

The CCT of Latinos with glaucoma in Puerto Rico seems to diminish as they age. Hahn and co-workers (10) showed that CCT in Latinos living in the continental US decreases as they age. One of the most constant associations suggests that CCT is thicker in younger individuals than in older individuals (16,18-25). This could be due to a decline in the density of keratocytes and a probable breakdown of the collagen fibers in the cornea (25). However, the mean CCT of patients ranging in age from 40 to 49 in our sample did not significantly differ to that of patients ranging in age from 70 to 79 ($t=0.8192$, $P=0.4133$). This suggests that Puerto Rican patients with glaucoma do not have a significant decrease in CCT as opposed to patients without glaucoma living in the continental US. Although the effect of age on CCT in patients with glaucoma has not been studied yet, our findings may be due to a Type II error. Further studies using larger samples are needed.

According to Goldmann and co-workers, (26) an increased CCT is related to an increased GAT IOP reading. In our study, as the mean IOP increased from 4 mm Hg to 20 mm Hg the mean CCT decreased. However, after 20 mm Hg, the mean CCT increased again. Previous studies (16) suggest that ocular hypertension is related to increasing CCT. As expected, patients with IOP higher than 21 mm Hg had an increased CCT. This finding may be due to corneal edema secondary to high IOP, which may lead to a high CCT value.

Limitations in our study include a small sample size, especially in age groups younger than 40 years-of-age. Furthermore, using historical controls may be a disadvantage because of lack of standardization.

In conclusion, this study suggests that CCT of Latinos in Puerto Rico is similar to that of Hispanics with glaucoma in the continental US. However, the CCT of Latinos in Puerto Rico was significantly higher than that of the general US population with glaucoma and the African American Population with glaucoma. Furthermore, the CCT of Latinos in Puerto Rico was significantly lower than that of the Caucasians with glaucoma in the continental US. In addition, the IOP and corrected IOP of

Latinos in Puerto Rico are significantly higher than that of Hispanics with glaucoma in the continental US. On the other hand, it seems that gender in the Latino population living in Puerto Rico does not affect CCT or IOP. Although patients without glaucoma living in the continental US have a significant decrease in CCT as they age, Puerto Rican patients with glaucoma did not show such a statistically significant relationship. Further studies with standardized controls and a larger sample size are needed to evaluate the population of Latinos living in Puerto Rico.

Resumen

Objetivo: Comparar las variaciones en el grosor corneal central y la presión intraocular, de acuerdo con la raza, género, y edad.

Métodos: Se llevó a cabo un estudio prospectivo no-concurrente de 372 (722 ojos) pacientes de glaucoma. El grosor corneal central se midió con un paquímetro de ultrasonido. La presión intraocular se midió con el tonómetro de Goldmann. La relación entre CCT, raza, género, y edad se evaluó utilizando tanto análisis estadístico como descriptivo.

Resultados: La edad poblacional fue 64 ± 19.52 años. El grosor corneal central promedio fue 546 ± 43.84 μm . La presión intraocular promedio corregida fue 17 ± 5.26 mmHg. El grosor corneal central de los pacientes masculinos (549 ± 43.43 μm) fue mayor que el de las féminas (546 ± 41.83 μm). La presión intraocular corregida en los pacientes masculinos (16 ± 5.41 mmHg) fue menos que las féminas (17 ± 5.18 mmHg). El grosor corneal promedio para las edades 0 a 9 años fue 548 ± 36.8 μm ; 10 a 19 años fue 606 ± 82.30 μm ; 20 a 29 años fue 564 ± 29.23 μm ; 30 a 39 años fue 579 ± 15.32 μm ; 40 a 49 años fue 546 ± 48.29 μm ; 50 a 59 años fue 550 ± 38.12 μm ; 60 a 69 años fue 545 ± 40.22 μm ; 70 a 79 años fue 541 ± 34.71 μm ; 80 a 89 años fue 541 ± 34.05 μm ; mayor de 90 años fue 527 ± 46.90 μm .

Conclusiones: El grosor corneal central en pacientes de glaucoma en Puerto Rico resultó similar al de los hispanos en los Estados Unidos. Sin embargo, la presión intraocular, resultó ser mayor en los pacientes puertorriqueños cuando se comparó con los pacientes hispanos en los Estados Unidos. En nuestro estudio ni el género, ni la edad afectaron el grosor corneal central ó la presión intraocular.

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