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Central Corneal Thickness in Glaucoma Patients at the Brazzaville University Hospital Center

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Abstract

Summary: We determined the value of central corneal thickness (CCT) in Congolese patients with primary open-angle glaucoma (POAG) and assessed its impact on intraocular pressure (IOP). **Patients and Methods:** We conducted a cross-sectional study at the University Hospital of Brazzaville. IOP was measured using a Goldmann applanation tonometer. Pachymetry was performed with an optical pachymeter (Topcon TRK-2P). Adjusted IOP was determined using the Ehlers correction table. Data were collected on standardized forms, entered using CSPro 7.4, and analyzed with the public health software SPSS 25. **Results:** Mean IOP in the right eye was 23.16 ± 8.66, with values ranging from 10 to 55. Mean IOP in the left eye was 23.21 ± 9.24, with values ranging from 10 to 57. Mean CCT in the right eye was 515.13 ± 38.23 µm, ranging from 434 to 590. Mean CCT in the left eye was 512.22 ± 34.56 µm, ranging from 435 to 582. Mean adjusted IOP in the right eye was 23.87 ± 8.05, ranging from 10 to 50. Mean adjusted IOP in the left eye was 23.88 ± 8.29, ranging from 10 to 57. The difference between mean adjusted IOP and non-adjusted IOP was statistically significant (p = 0.03). **Conclusion:** Patients with POAG have corneas that are thinner than the Caucasian average, which results in overestimated ocular pressures that must be taken into account for diagnosis, treatment, and follow-up.

Keywords

Primary Open-Angle Glaucoma, Central Corneal Thickness, Pachymetry, Intraocular Pressure

1. Introduction

Ocular hypertension (OHT) is not part of the definition of primary open-angle glaucoma (POAG), but it is an alert sign that guides evaluation and referral [1]. The reference instrument for measuring intraocular pressure remains the Goldmann applanation tonometer [2]. This instrument was calibrated for a central corneal thickness (CCT) of 520 µm [3] [4]. However, corneal thickness is not a constant; it varies between patients. It is thinner in African Americans and Africans than in White Caucasian subjects [5]. Thus, when CCT is higher than normal, IOP will be overestimated, and when CCT is lower than normal, IOP will be underestimated.

Worldwide studies place normal CCT between 527 and 560 µm [6] [7]. A few studies in sub-Saharan Africa report corneas that are thinner than the Caucasian average [8]-[11]. To date, no study on CCT has been conducted in Congo-Brazzaville.

The objective of this study is to assess the importance of measuring central corneal thickness in Congolese patients with glaucoma.

2. Patients and Methods

2.1. Study Type and Period

This was an analytical cross-sectional study conducted from January 1, 2025 to June 30, 2025 (6 months).

2.2. Study Setting

The study took place in the Ophthalmology Department of the University Hospital Center of Brazzaville (CHU-B).

2.3. Study Population

2.3.1. Target Population

The target population consisted of all patients with POAG who attended during the study period.

2.3.2. Inclusion Criteria

- Patients followed for POAG.
- Age 20 years or older.
- Patients who provided informed consent.

2.3.3. Non-Inclusion Criteria

- Patients younger than 20 years.
- Non-transparent ocular media.
- Corneal abnormalities.

2.3.4. Sampling

We used a systematic, non-probability sampling of patients meeting inclusion criteria during the study period.

2.4. Study Procedures

All selected patients underwent a complete ophthalmologic examination.

2.4.1. Interview

- Collection of socio-occupational data.
- Assessment of a history of glaucoma.

2.4.2. Refraction

Distance visual acuity was assessed using the Monoyer chart. Based on visual acuity, patients were grouped according to the WHO classification. Autorefractometry was performed with the Topcon TRK-2P.

2.4.3. Slit-Lamp Examination

To assess the transparency of ocular media.

2.4.4. IOP Measurement and Pachymetry

- **IOP measured with a regularly calibrated Goldmann applanation tonometer** in patients with or without glaucoma follow-up, regardless of treatment adherence; the IOP value retained for analysis was the **mean of three consecutive measurements**, taken at the **same time each morning over three consecutive days**.
- Pachymetry using the optical pachymeter (Topcon TRK-2P).
- Adjusted IOP determined using the Ehlers table [4].

2.4.5. Fundus Examination

Using a 90-diopter lens.

2.4.6. Visual Field Assessment and OCT

To confirm glaucoma.

2.4.7. Confirmation of the Diagnosis of Glaucoma

Based on the presence of at least 3 suggestive findings:

- Ocular hypertension (OHT)/elevated intraocular pressure (IOP).
- Increased optic disc cupping (increased papillary excavation).
- Visual field abnormalities.
- OCT abnormalities (optical coherence tomography).

2.5. Statistical Analysis

Data were collected on forms, entered using CSPro 7.4, and analyzed using SPSS 25. Tables and graphs were generated with Microsoft Excel 2016. Frequencies of qualitative variables were compared using the chi-square test. Statistical significance was set at $p \leq 0.05$.

3. Results

The mean age of patients was 60.98 ± 13.40 years, with a range from 21 to 93 years. The most represented age group was 60 and older (54.63%) (see **Table 1**). By sex,

mean age was 62.67 ± 10.57 years in men versus 59.57 ± 9.16 years in women (see Table 2). The sex ratio was 0.83.

58.33% of patients had visual acuity ≥ 3/10 (see Table 3). Only 11.11% of right eyes had IOP ≥ 30, compared with 15.74% of left eyes (see Table 4).

Table 1. Distribution of patients by age group.

Age group	Number (n)	Percentage (%)
20 - 39 years	4	3.70
40 - 59 years	45	41.67
60 years and older	59	54.63
Total	**108**	**100**

Table 2. Mean age of patients by sex.

Sex	Number	Mean age
Male	69	62.67 ± 10.57
Female	59	59.57 ± 9.16

Table 3. Distribution of patients according to visual acuity.

Visual acuity	RE: Number (n)	RE: Percentage (%)	LE: Number (n)	LE: Percentage (%)
<1/10	16	14.81	14	12.96
1/10 - 3/10	24	22.22	31	28.70
≥3/10	68	62.96	63	58.33
Total	**108**	**100**	**108**	**100**

RE = right eye; LE = left eye.

Table 4. Distribution of patients according to IOP.

IOP (mmHg)	RE: Number (n)	RE: Percentage (%)	LE: Number (n)	LE: Percentage (%)
<22	47	43.52	55	50.93
22 - 29	49	45.37	36	33.33
≥30	12	11.11	17	15.74
Total	**108**	**100**	**108**	**100**

Mean IOP in the right eye was 23.16 ± 8.66, with values ranging from 10 to 55.

Mean IOP in the left eye was 23.21 ± 9.24, with values ranging from 10 to 57.

Mean CCT in the right eye was 515.13 ± 38.23 µm, with values ranging from 434 to 590.

Mean CCT in the left eye was 512.22 ± 34.56 µm, with values ranging from 435 to 582.

The difference in mean CCT between the two eyes was not statistically significant (p = 0.084).

Mean CCT of the right eye in men was 512.26 ± 23.69 µm.

Mean CCT of the right eye in women was 517.83 ± 25.99 µm.

The difference in mean right-eye CCT between sexes was not statistically significant (p = 0.273).

Mean CCT of the left eye in men was 513.11 ± 23.20 µm.

Mean CCT of the left eye in women was 511.51 ± 25.60 µm.

The difference in mean left-eye CCT between sexes was not statistically significant (p = 0.357).

CCT decreased with age (see Table 5).

After adjusting IOP for pachymetry, 19.96% had IOP ≥ 30 in the right eye and 18.58% in the left eye (see Table 6).

Mean adjusted IOP in the right eye was 23.87 ± 8.05, with values ranging from 10 to 50.

Mean adjusted IOP in the left eye was 23.88 ± 8.29, with values ranging from 10 to 57.

The difference between mean adjusted IOP and non-adjusted IOP was statistically significant (p = 0.03) (see Table 7).

Table 5. Mean CCT by age group.

Age group	RE: Mean	RE: SD	LE: Mean	LE: SD
20 - 49 years	546	7.24	547	8.40
40 - 60 years	515.02	21.63	514.35	28.74
Over 60 years	512.00	34.65	508.21	30.54

CCT = central corneal thickness; RE = right eye; LE = left eye.

Table 6. Distribution of patients according to adjusted IOP.

Adjusted IOP (mmHg)	RE: Number (n)	RE: Percentage (%)	LE: Number (n)	LE: Percentage (%)
<22	44	40.74	51	47.22
22 - 29	50	46.30	37	34.26
≥30	14	12.96	20	18.58
Total	**108**	**100**	**108**	**100**

Table 7. IOP vs adjusted IOP.

Eye	Measure	Number	Mean	SD	p-value
RE	IOP	108	23.16	8.66	0.003
RE	Adjusted IOP	108	23.87	8.05	0.003
LE	IOP	108	23.21	9.24	0.003
LE	Adjusted IOP	108	23.88	8.29	0.003

4. Discussion

4.1. Sociodemographic Characteristics

4.1.1. Age

The mean age of patients was 60.98 ± 13.40 years. This varies across studies: Ndiaye-Sow in Senegal [12], Lee in Korea [13], Singh in Australia [14], and Baudoin in France [15] reported mean ages of 56.53 ± 11.29 years, 57.2 ± 12.6 years, 59 ± 16 years, and 63 ± 13 years, respectively. The most represented age group in our study was over 60 years (54.63%).

4.1.2. Sex

There was a female predominance (54.63%), with a sex ratio of 0.83. Denis *et al.* [16] and Baudoin [15] in France also found a female predominance (56.15% and 56%, respectively). Conversely, Watson [17] in England reported a male predominance (65.7%). Male sex is sometimes considered a risk factor for POAG [18].

4.2. Clinical Characteristics

4.2.1. Visual Acuity

Most patients had visual acuity greater than 3/10: 62.96% in the right eye and 58.33% in the left eye. Preservation of good visual acuity despite glaucoma progression is often described [19].

4.2.2 Non-Adjusted Intraocular Pressure

Mean IOP was 23.16 ± 8.66 mmHg in the right eye and 23.21 ± 9.24 mmHg in the left eye. Pretreatment IOP reported in the literature among glaucoma patients varies across studies and sampling. Ndiaye-Sow [12] found mean IOP of 27.54 ± 7.51 mmHg (right) and 26.76 ± 6.67 mmHg (left). Singh [14] in Australia reported 27.5 ± 5.1 mmHg. These were slightly higher than ours. Ouattara in Côte d'Ivoire [20], however, reported a mean IOP of 18.43 ± 4.18 mmHg.

4.2.3. Central Corneal Thickness

We found mean CCT of 515.13 ± 38.23 µm in the right eye and 512.22 ± 34.56 µm in the left eye. These results are close to those from African studies evaluating corneal thickness in POAG patients: 506.69 ± 35.08 µm reported by Tolesa [21] in Ethiopia; 519.6 ± 32.6 µm by Fanny [8] in Côte d'Ivoire; 525.40 ± 39.63 µm by Ndiaye-Sow [12] in Senegal; and 529.29 ± 35.9 µm by Eballé [9] in Cameroon.

This thickness appears higher in Caucasians; Khoramnia [22] in Germany found a CCT of 539.62 ± 31.87 µm. In the Nemesure study [23] in Barbados, CCT increased clearly from Black to White subjects: 529.8 µm in Blacks, 537.8 µm in Black–White mixed-race individuals, and 545.2 µm in Whites.

We did not find a sex-related difference in CCT, similar to Nemesure [23] in Barbados and Bron [24] in France. In contrast, Mercieca [25] in Nigeria found thinner corneas in men than in women.

CCT decreased with age in our study, as also observed by Nemesure [23]. However, we used optical pachymetry, which may yield lower values. In a meta-analy-

sis, Doughty [7] found that optical measurements produced lower CCT values than ultrasound measurements.

4.2.4. Adjusted Intraocular Pressure

Many techniques are available for measuring intraocular pressure (IOP), but the reference technique in clinical practice remains Goldmann applanation tonometry, which is influenced by multiple parameters, particularly central corneal thickness (CCT). IOP should be systematically adjusted for CCT, since a thin cornea leads to underestimation of IOP values, whereas a thick cornea leads to overestimation [26].

Mean adjusted IOP was 23.87 mmHg in the right eye and 23.88 ± 8.29 mmHg in the left eye. Adjusted IOP was higher than non-adjusted IOP, and the difference was statistically significant ($p = 0.03$). This higher IOP reflects the thinner CCT. The thinner cornea in Black African subjects explains the generally underestimated IOP measurements [7] [27]; these are in fact "falsely" low measurements because they are underestimated.

The difference between non-adjusted and adjusted IOP was statistically significant ($p = 0.03$). The relationship between CCT and IOP was established by Ehlers *et al.* as early as 1975 [4]. This relationship is further supported by IOP variations that follow corneal thickness after LASIK [7] [28]. Because our patients had CCT values below the norm, they are exposed to underestimation of their IOP.

5. Conclusions

Central corneal thickness is an important parameter that should not be overlooked in the follow-up of chronic open-angle glaucoma.

This study showed that CCT in glaucoma patients followed at the University Hospital of Brazzaville is thinner than average. Therefore, IOP values obtained in clinic in glaucoma patients are usually underestimated to a non-negligible degree. This underestimation may lead the clinician to diagnostic errors or insufficient therapeutic adjustment of IOP, allowing glaucoma to continue progressing.

It is therefore necessary to take this underestimation into account in glaucoma management, especially in centers that do not yet have a pachymeter. Centers equipped with a pachymeter should systematically follow patients using adjusted IOP.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Lamirel, C. (2020) Et si c'était un glaucome in neuro-ophtalmologie pratique. Rapport SFO, Elsivier.

[2] Roszkowska, A.M., De Grazia, L., Cirone, M. and Ferreri, G. (2009) Comparison of Goldmann Applanation Tonometry and Dynamic Contour Tonometry in the Measurement of Intraocular Pressure in Eyes with Different Corneal Thicknesses. *Oph-*

thalmologica, **223**, 244-249. https://doi.org/10.1159/000209253

[3] Copt, R. (1999) Corneal Thickness in Ocular Hypertension, Primary Open-Angle Glaucoma, and Normal Tension Glaucoma. *Archives of Ophthalmology*, **117**, 14-16. https://doi.org/10.1001/archopht.117.1.14

[4] Ehlers, N., Bramsen, T. and Sperling, S. (1975) Applanation Tonometry and Central Corneal Thickness. *Acta Ophthalmologica*, **53**, 34-43. https://doi.org/10.1111/j.1755-3768.1975.tb01135.x

[5] La Rosa, F.A., Gross, R.L. and Orengo-Nania, S. (2001) Central Corneal Thickness of Caucasians and African Americans in Glaucomatous and No Glaucomatous Populations. *Archives of Ophthalmology*, **119**, 23-27.

[6] Damji, K.F., Muni, R.H. and Munger, R.M. (2003) Influence of Corneal Variables on Accuracy of Intraocular Pressure Measurement. *Journal of Glaucoma*, **12**, 69-80. https://doi.org/10.1097/00061198-200302000-00015

[7] Doughty, M.J. and Zaman, M.L. (2000) Human Corneal Thickness and Its Impact on Intraocular Pressure Measures: A Review and Metaanalysis Approach. *Survey of Ophthalmology*, **44**, 367-408. https://doi.org/10.1016/s0039-6257(00)00110-7

[8] Fanny, A., Ouattara, A., Coulibaly, F., Nigué, L., Gbé, K., Bérété-Coulibaly, R., *et al.* (2008) Épaisseur cornéenne centrale et erreur potentielle de la tonométrie à aplanation de Goldmann chez le patient noir africain atteint de glaucome primitif à angle ouvert. *Journal Français d'Ophtalmologie*, **31**, 405-408. https://doi.org/10.1016/s0181-5512(08)71435-9

[9] Eballe, A., Koki, G., Ellong, A., Owono, D., Epée, E., Bella, L.A., Ebab Mvogo, C. and Kouam, M.J. (2010) Central Corneal Thickness and Intraocular Pressure in the Cameroonian Nonglaucomatous Population. *Clinical Ophthalmology*, **4**, 717-724. https://doi.org/10.2147/opth.s10575

[10] Eballe, A., Epee, E., Koki Godefroy, and Bella, A. (2010) Analysis of Central Corneal Thickness in Black Cameroonian Children. *Clinical Optometry*, **2**, 113-117. https://doi.org/10.2147/opto.s14214

[11] Ayena, D.K., Banla, M. and Balo, K.P. (2013) Distribution de l'épaisseur cornéenne centrale dans une population mélanoderme. *Journal Français d'Ophtalmologie*, **36**, 112-116. https://doi.org/10.1016/j.jfo.2012.06.008

[12] Ndiaye-Sow, M.N., Dieng, M., Seck, S.M., Agboton, G.A., Diakhaté-Diouf, M., Gueye, N.N., *et al.* (2014) Épaisseur cornéenne centrale chez le mélanoderme sénégalais atteint de glaucome primitif à angle ouvert. *Journal Français d'Ophtalmologie*, **37**, 535-539. https://doi.org/10.1016/j.jfo.2014.01.007

[13] Lee, E.S., Kim, C.Y., Ha, S.J., Seong, G.J. and Hong, Y.J. (2007) Central Corneal Thickness of Korean Patients with Glaucoma. *Ophthalmology*, **114**, 927-930. https://doi.org/10.1016/j.ophtha.2006.09.036

[14] Singh, R.P., Goldberg, I., Graham, S.L., Sharma, A. and Mohsin, M. (2001) Central Corneal Thickness, Tonometry, and Ocular Dimensions in Glaucoma and Ocular Hypertension. *Journal of Glaucoma*, **10**, 206-210. https://doi.org/10.1097/00061198-200106000-00011

[15] Baudouin, C., Rouland, J.-F., Nordmann, J.-P., Bron, A. and Pelen, F. (2006) Efficacité du latanoprost, donné en première ou deuxième intention, sur la pression intra-oculaire et la symptomatologie oculaire chez des patients présentant un glaucome à angle ouvert ou une hypertension oculaire simple. *Journal Français d'Ophtalmologie*, **29**, 615-624. https://doi.org/10.1016/s0181-5512(06)73821-9

[16] Denis, P. (2009) Mieux comprendre les relations entre cornée et PIO. *Réflexions*

Ophtalmologiques, **124**, 168-175

[17] Watson, P.G. (1998) Latanoprost: Two Years' Experience of Its Use in the United Kingdom. *Ophthalmology*, **105**, 82-87. https://doi.org/10.1016/s0161-6420(98)91372-0

[18] Tham, Y., Li, X., Wong, T.Y., Quigley, H.A., Aung, T. and Cheng, C. (2014) Global Prevalence of Glaucoma and Projections of Glaucoma Burden through 2040: A Systematic Review and Meta-Analysis. *Ophthalmology*, **121**, 2081-2090. https://doi.org/10.1016/j.ophtha.2014.05.013

[19] Takahashi, N., Omodaka, K., Kikawa, T., Akiba, M. and Nakazawa, T. (2021) Association entre les caractéristiques topographiques du faisceau de fibres nerveuses rétiniennes et une bonne acuité visuelle chez les patients atteints de glaucome. *Current Eye Research*, **46**, 1724-1731. https://doi.org/10.1080/02713683.2021.1912782

[20] Ouattara, O.A.S., Coulibaly, F., Ouffoué, Y.G., Ouattara, A., Konan, A.J., Kouassi, L.J., *et al.* (2019) Trabéculoplastie sélective chez le mélanoderme africain. *Journal Français d'Ophtalmologie*, **42**, 44-48. https://doi.org/10.1016/j.jfo.2018.02.018

[21] Tolesa, K. and Gessesse, G.W. (2016) Central Corneal Thickness in Newly Diagnosed Glaucoma Patients in South West Ethiopia: A Cross-Sectional Study. *BMC Ophthalmology*, **16**, Article No. 152. https://doi.org/10.1186/s12886-016-0334-x

[22] Khoramnia, R., Rabsilber, T.M. and Auffarth, G.U. (2007) Central and Peripheral Pachymetry Measurements According to Age Using the Pentacam Rotating Scheimpflug Camera. *Journal of Cataract and Refractive Surgery*, **33**, 830-836. https://doi.org/10.1016/j.jcrs.2006.12.025

[23] Shimmyo, M., Ross, A.J., Moy, A. and Mostafavi, R. (2003) Intraocular Pressure, Goldmann Applanation Tension, Corneal Thickness, and Corneal Curvature in Caucasians, Asians, Hispanics, and African Americans. *American Journal of Ophthalmology*, **136**, 603-613. https://doi.org/10.1016/s0002-9394(03)00424-0

[24] Bron, A., Chapard, J., Creuzot-Garcher, C., Guerzider, V. and D'athis, P. (1999) La mesure de l'épaisseur cornéenne est-elle fiable et utile? *Journal Français d'Ophtalmologie*, **22**, 160-168.

[25] Mercieca, K., Odogu, V., Fiebai, B., Arowolo, O. and Chukwuka, F. (2007) Comparing Central Corneal Thickness in a Sub-Saharan Cohort to African Americans and Afro-Caribbeans. *Cornea*, **26**, 557-560. https://doi.org/10.1097/ico.0b013e3180415d90

[26] Hamard, P. (2010) Que faire si la mesure de la pression intraoculaire semble peu fiable? *Journal Français d'Ophtalmologie*, **33**, 279-284. https://doi.org/10.1016/j.jfo.2010.02.007

[27] Whitacre, M.M., Stein, R.A. and Hassanein, K. (1993) The Effect of Corneal Thickness on Applanation Tonometry. *American Journal of Ophthalmology*, **115**, 592-596. https://doi.org/10.1016/s0002-9394(14)71455-2

[28] Emara, B., Probst, L.E., Tingey, D.P., Kennedy, D.W., Willms, L.J. and Machat, J. (1998) Correlation of Intraocular Pressure and Central Corneal Thickness in Normal Myopic Eyes and after Laser *in Situ* Keratomileusis. *Journal of Cataract and Refractive Surgery*, **24**, 1320-1325. https://doi.org/10.1016/s0886-3350(98)80222-8