Central Corneal Thickness in Newly Diagnosed Cameroonian Glaucoma Patients with ‘Normal’ Intraocular Pressures

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Abstract

Aim: To test if central corneal thickness (CCT) and intraocular pressure (IOP) are related in patients with glaucoma and normal IOPs.

Methods: A prospective descriptive study which took place from September 1 to December 31, 2014 at the Presbyterian Eye Clinic Acha-Douala, Cameroon. Consenting newly diagnosed glaucoma patients with normal IOP were included. IOP was measured using applanation tonometry. CCT was measured in both eyes of all patients and a correction factor for IOP was read from the chart provided by the manufacturer based on the CCT.

Results: Fifty-three consenting patients (106 eyes) were included, comprising 24 males (45%). The mean age was 34 ± 16 years. The mean CCT in all eyes was 529 ± 36 μm (range: 433 to 594 μm). The mean CCT for the right and left eyes were 526 ± 36 μm and 528 ± 37 μm, respectively. The mean uncorrected IOP for all eyes was 16 ± 3 mmHg. The mean corrected IOP for all eyes was 17 ± 3 mmHg. The difference between the uncorrected and corrected IOP for all eyes was found to be statistically significant (P < 0.0001).

Conclusion: Measured IOP in most glaucoma patients with ‘normal’ IOP needs to be corrected. We suggest that the measurement of CCT be part of the routine workup of patients with glaucoma in order to permit a more precise estimation of IOP, hence target pressure in order to assure a better follow up.

Keywords: Central corneal thickness; Glaucoma; Cameroon

Abbreviations

CCT: Central Corneal Thickness; IOP: Intraocular Pressure; POAG: Primary Open Angle Glaucoma

Introduction

Intraocular pressure (IOP) is known to be the most important risk factor for glaucoma as the risk of glaucomatous optic nerve damage increases with increasing IOP [1,2]. The Early Manifest Glaucoma Trial reported delayed in progression of the disease with lowering the IOP in patients with open-angle glaucoma who have elevated and normal IOP [3,4]. Even though factors other than the IOP are involved, the IOP is the most important risk factor, because it is the only risk factor which can be pharmacomodulated to date.

Measuring the IOP is therefore essential in the diagnosis and follow-up of patients with glaucoma. Central corneal thickness (CCT) among other factors can influence the accuracy of Goldman applanation tonometry. IOP may be overestimated or underestimated in thick or thin corneas, respectively. The Goldmann tonometer provided accurate readings only when the CCT was 520 μm [5]. Thin corneas may result in a 4 to 9 mmHg underestimation of IOP, and thick corneas may result in overestimation of the IOP by an average of 6.8 mmHg [6].

Studies on CCT in Cameroonian populations have confirmed that blacks have thinner corneas compared to Caucasians and Asians, but were comparable with those reported for Africans and African-Americans [7,8]. The relationship between CCT and IOP in the non-glaucomatous population has been studied [7] while the same relationship has been evaluated in a Cameroonian population with isolated ocular hypertension and primary open angle glaucoma (POAG) [8].

CCT has not yet been reported among patients with glaucoma and normal values of IOP. The aim of this study was therefore to evaluate the CCT and corrected IOP in patients that were recently diagnosed with glaucoma and had a normal IOP.

Methods

This was a prospective descriptive study which was carried out at the Presbyterian Eye Clinic Acha-Douala, Cameroon from September 1 to December 31, 2014. Ethical clearance was obtained from the Institutional Ethical Committee. The diagnosis of glaucoma was based on the presence of a typical glaucomatous disc (cup/disc ratio > 0.4) and characteristic glaucomatous field loss. Gonioscopy was done in all cases. All patients included in this study were examined by the same ophthalmologist.

IOP was measured with a slit lamp-mounted Goldmann applanation tonometer (BQ 900® model by Haag-Streit). The mean of three measurements before the initiation of antiglaucoma therapy was recorded for each eye. CCT was measured using a hand-held ultrasonic pachymeter (Pocket II model by Quantel Medical SAS). This pachymeter has a range of 200 to 999 μm and an accuracy of ± 5 μm. It automatically prevents measurements when the probe is not perpendicular. Visual fields were tested using the Humphrey automated perimeter.

Consenting patients that were recently diagnosed with glaucoma and had normal IOPs (≤ 21 mmHg) were included. Patients presenting an ocular surface infection or corneal pathology which could influence the CCT were excluded. CCT was measured by the same examiner. Each patient received a drop of topical anaesthetic (0.5% Tetracaine hydrochloride) 2 minutes prior to measurement. Patients were asked to blink to avoid bias from corneal drying and then asked to fixate on a target at distance. The pachymeter probe was then placed perpendicularly on the cornea at the centre of the pupil. Five measurements were taken over the same spot and the mean reading was considered for each eye. The measurement was considered good when the standard deviation of the mean was < 5 μm, given the accuracy of the pachymeter.

A correction factor for IOP was read from a chart provided for by the manufacturer which is based on the data of Ehlers et al [5] who calculated the error which was evoked by a thinner or a thicker cornea to be 0.7 mmHg per 10 μm deviation from the normal value of 520 μm. Corrected IOP values were then recorded.
With regards to the CCT adjusted IOP values, we defined outcomes as defined by Shih et al [9]. Measurement significant changes referred to IOP corrections of 1.5 mmHg or greater (in either direction) and the outcome significant changes as IOP adjustments of 3.0 mmHg or greater.

Data collected included gender, age, measured IOP, corrected IOP and CCT. Data analysis was performed using the statistical software Stata version 12 (College Station: StataCorp LP). A threshold of 5% (P < 0.05) was considered significant.

**Results**

During the study period, 53 patients (106 eyes) comprised of 24 males (45%) met the inclusion criteria. The mean age was 34 ± 16 years. The most represented age group was 20-39 years-old, accounting for 40% (n = 21) of the total. The mean uncorrected IOP for all eyes was 15 ± 3 mmHg with a range of 11 to 20 mmHg. The mean for the right eyes was 16 ± 3 mmHg and that for the left eyes was 15 ± 3 mmHg.

The mean CCT in all eyes was 529 ± 36 µm with a range of 433 to 594 µm. The mean CCT for the right and left eyes were 526 ± 36 µm and 528 ± 37 µm, respectively.

Scatter plots showed that CCT did not vary much with age (Figure 1) but increased with increasing uncorrected IOP (Figure 2). Linear regression analysis showed no statistically significant correlation between CCT and age. The regression coefficient between CCT and uncorrected IOP was 4.717 [95% CI: 2.252-7.181], P < 0.0001 (Table 1).

The mean corrected IOP for all eyes was 17 ± 3 mmHg. Table 2 shows the mean corrected IOP for right and left eyes. The difference between the uncorrected and corrected IOP for all eyes was found to be statistically significant (P < 0.0001).

Forty patients (75.5%) required correction for the measured IOP. Measurement significant adjustments was observed in 69.8% of patients (n = 37) and outcomes significant adjustments in 50.6% of patients (n = 27). When IOP was corrected, 6 patients (11.3%) had corrected IOP of at least 21 mmHg, representing high pressure glaucoma. The maximum underestimation of IOP was 7.0 mmHg and the maximum overestimation was 3 mmHg.

**Discussion**

The mean CCT of our cases was 529 ± 36 µm which was not significantly different than the value 521 ± 31 µm for Caucasians with normal tension glaucoma [10]. Our value for CCT was significantly different than 518 ± 0.5 µm reported for Caucasian patients by Ventura et al [11]. This difference could be explained by the techniques used in measuring CCT. There is good agreement between the non-contact optical low coherence reflectometry (OLCR) and the contact ultrasonic pachymetry. However, the OLCR pachymetry is reported to show better repeatability (low variability with lesser standard deviation of measurements) [12,13]. Ariani et al reported that the OLCR pachymeter measured an average of 4.64 µm less than the ultrasonic pachymeter [14].

Several comparative studies report thinner corneas in patients with normal tension glaucoma compared to those with POAG; as well as healthy subjects [10,15,16]. However other studies both in whites and blacks show that CCT of subjects with glaucoma is similar to that of healthy subjects [17,18]. The mean CCT in Cameroonian patients with POAG (526 ± 37 µm, n = 120 eyes) [8] was similar to that of a non-glaucomatous population (529 ± 36 µm, n = 970 eyes) [7]. Compared to this normal Cameroonian population, the mean CCT in our patients does not differ from the non-glaucomatous population.

In our study population, there was a significant positive correlation between CCT and uncorrected IOP in agreement with numerous studies [7,19-21]. Even though the impact of CCT on IOP is clear, there is no universal consensus on the formula for IOP adjustment.

### Table 1: Linear regression analysis of central corneal thickness against age and intraocular pressure

<table>
<thead>
<tr>
<th>CCT (µm)</th>
<th>Uncorrected IOP mean ± SD (mmHg)</th>
<th>Corrected IOP mean ± SD (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right eye</td>
<td>15 ± 3</td>
<td>17 ± 3</td>
</tr>
<tr>
<td>Left eye</td>
<td>15 ± 3</td>
<td>16 ± 3</td>
</tr>
<tr>
<td>Both eye</td>
<td>16 ± 3</td>
<td>16 ± 3</td>
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</table>

**Table 2: Mean uncorrected and corrected intraocular pressure (IOP) for the eyes in the study population.**

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adjustment. Different formulas have been developed to correct the IOP. Ehlers et al [5] calculated the error which was evoked by a thinner or a thicker cornea to be 0.7 mmHg per 10 μm deviation from the normal value of 520 μm [5]. Doughty and Zaman’s meta-analysis study showed that a 10% difference in the CCT would result in a 3.4 ± 0.9 mmHg difference in the IOP [22]. They suggest that a correction of 2 or 3 mmHg be made for each 0.05 mm difference in CCT from 0.535 mm. Shih et al, used a linear correction formula which was based on an extensive literature review and 2.5 mmHg was added or subtracted for every 50 μm deviation in the CCT from the reference value 527.6 μm [9]. This has been used by other authors [15]. In our study, we used the correction chart provided for by the manufacturer of the Pocket II pachymeter to ease clinical practice which is based on the data of Ehlers et al. [5].

Measurement significant adjustments was observed in 69.8% of patients (n = 37) and outcomes significant adjustments in 50.59% of patients (n = 27). Shih et al [9] observed measurement significant adjustments in 55.9% patients and the outcomes significant adjustments in 20.2% patients, based on which the alterations in the glaucoma treatment plan were noted. Shetgar et al [15] however reported that none of their patients (n = 22) showed outcomes significant changes.

Reclassification done following the IOP correction based on the CCT in our study showed that, 11.3% (n = 6/53) were reclassified as having high pressures. This differs from 22.73% and 31% reported by Shetgar et al [15]and Copt et al respectively [10]. The relatively low rate of reclassification in our study can be explained by the fact that the CCT of our patients is relatively thicker than those reported by the other two authors. The mean CCT in our cases is closer to that of non-glaucomatous patients previously reported in our setting [7]

Conclusion

Measured IOP in most glaucoma patients with ‘normal’ IOP needs to be corrected with respect to CCT; with up to 11.3% reclassification of patients in this series. We suggest that measurement of CCT should be part of the routine workup of glaucoma patients with ‘normal’ IOP in order to avoid under treatment. A comparative study is recommended to compare the CCT of glaucoma patients with ‘normal’ IOP with those of POAG, ocular hypertension and normal subjects in our setting.

References