Evaluation of central corneal thickness in patients with ocular hypertension and primary open-angle glaucoma

Mirjana A. Janićijević-Petrović¹, Tatjana S. Šarenac-Vulović¹, Katarina M. Janićijević², Dejan A. Vulović², Popovic B. Andrijana², Dragan I. Vujić³

¹Clinic of Ophthalmology, Clinical Centre in Kragujevac, ²Faculty of Medical Sciences, University of Kragujevac, ³State University of Novi Pazar; Serbia

ABSTRACT

Aim To determine correlation between central corneal thickness (CCT) and applanation intraocular pressure (IOP) in normal patients with primary open angle glaucoma and patients with ocular hypertension.

Methods Two-year retrospective study designed to determine correlation between CCT and IOP. Records of 121 patients were included in the study. Inclusion criteria were: IOP higher than 22 mm Hg for a group with ocular hypertension but without functional, morphological damage and progression, diagnosis of glaucoma for a group with open-angle glaucoma and normal ophthalmological results for a control group. Patients who were mono-ocular, patients with secondary glaucoma and who had surgical treatment were excluded. The patients were selectively grouped according to types of glaucoma, by gender and age. The IOP values were measured by Goldman’s applanation tonometer, CCT values were determined using ultrasonic pachymeter, in the period from January 2011 to December 2012.

Results Of total 121 subjects, 51 had primary open angle glaucoma (POAG), 40 had ocular hypertension (OHT) and 30 had normal ophthalmological findings (control group). The CCT values in OHT group 529.37 +/- 25.18 µm were greater than of both POAG, 501.02 +/- 14.04 µm and control group, 497.37 +/- 14.90 µm. The IOP values in OHT group were 20.25 +/- 3.62 mm Hg, and in POAG group were 18.25 +/- 2.70 mm Hg, while in the control group they were 13.53 +/- 3.62 mm Hg.

Conclusion Determination of CCT in patients with glaucoma is crucial, considering its impact on IOP values, which represents a parameter in glaucoma diagnosis, as well as monitoring further progress of ocular hypertension and patients diagnosed with glaucoma.

Keywords: glaucoma disease, Goldman’s tonometer, ultrasonic pachymeter
INTRODUCTION

Glaucoma is the second leading cause of blindness in the world, and the third in Serbia (1, 2). The intraocular pressure (IOP) is essential in diagnosis of glaucoma and it is also known as a modifiable risk factor (3, 4). Patients with intraocular hypertension whose central corneal thickness (CCT) is increasing are considered to be at higher risk of developing open angle glaucoma (5). In eyes with thin cornea the glaucoma progression tends to appear earlier, which suggests a need for lower target IOP for monitoring of those patients (10). Ophthalmologists bring forward that CCT measurement should be one of the regular examinations in the treatment and prognostic assessment of patients with glaucoma disease (11-13). Values of IOP and CCT may account for measurement error induced by known corneal biomechanics. Compared to Goldman’s applanation tonometer, IOP and CCT may be superior tests in the evaluation of glaucoma, however, is unlikely that they will represent an effective diagnostic test (19).

The aim of the study was to determine the relationship between CCT and IOP in patients with POAG, OHT and control group, to put diagnostics in the service of an adequate therapy by monitoring patients with intraocular hypertension, as well as those who had already been diagnosed with glaucoma disease (to prevent farther damage).

PATIENTS AND METHODS

Retrospective study included three groups of patients: patients with primary open angle glaucoma, patients with ocular hypertension and patients with normal ophthalmological results as a control group. Age–primary open angle glaucoma (POAG), ocular hypertension (OHT) and control group were 15-30, 31-45, 46-60 and >60 years of age. Patients were selected from standard protocols of patients who were visiting Clinic of Ophthalmology in Clinical Centre Kragujevac in Kragujevac, Central Serbia in the period between January 2011 and December 2012. The Ethics Committee of the Clinical Centre of Kragujevac, in Kragujevac, approved this study.

A total of 121 subjects (242 eyes) were included in the study and categorized into three groups according to IOP, cup-to-disc ratio (obtained by indirect fundus examination, e.g. morphological damages), and visual field parameters (obtained by three Octopus - perimetry tests e.g. functional damages): the patients with open angle glaucoma, ocular hypertension and control group, respectively. Inclusion criteria were: for the group with ocular hypertension IOP higher than 22 mm Hg but without functional and morphological damage and progression, for the group with open angle glaucoma standard clinical diagnosis of glaucoma, and normal ophthalmological results for the control group. Patients who were functional mono-ocular for any reason, patients with secondary glaucoma and patients who had any surgical treatment for glaucoma were excluded. All measurements were performed under topical anesthesia (tetracaine sol. 1%). The IOP values were measured by Goldman’s applanation tonometer, while CCT values were measured by ultrasonic pachymeter (ultrasonic pachymeter, Heidelberg Engineering Germany). Top anesthetized cornea was gently touched by a small ultrasonic probe with one touch by ten consecutive measurements. In its software system this machine has ten consecutive measurements, formulas for calculating the IOP in relation to the measured thickness of the cornea and correction factor of IOP, each changed in CCT for 10-20 µm, changes of IOP values for 1 mm Hg. The IOP was measured three times (middle value), each consecutively using the Goldman’s applanation tonometry. Analyses of variance were used for the comparison of CCT between groups determined by types of glaucoma, subdivided by age and gender.

Frequency (the diagnoses of OHT, POAG and control group) subdivided to the sex and the age group of the patients were performed by Chi-square test, t-test, and p< 0.01 was taken for statistical significance (CCT and IOP were presented in mean +/- 2 SD).

RESULTS

Of the total 121 (242 eyes) patients who were included in study, 51 (102 eyes) (42.15%) had primary open angle glaucoma (POAG), 40 (80 eyes) (33.06%) had ocular hypertension (OHT) and 30 (60 eyes) (24.79%) were patients with normal ophthalmological results (Table 1).
Table 1. Age and sex distribution of primary open angle glaucoma, ocular hypertension and control group with central corneal thickness

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>POAG</th>
<th>OHT</th>
<th>Control</th>
<th>Total</th>
<th>CCT (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-30</td>
<td>3 F</td>
<td>2 M</td>
<td>3 F</td>
<td>2 M</td>
<td>15 (12.40) 524.58</td>
</tr>
<tr>
<td>31-45</td>
<td>8 F</td>
<td>7 M</td>
<td>7 F</td>
<td>5 M</td>
<td>39 (32.23) 518.15</td>
</tr>
<tr>
<td>46-60</td>
<td>9 F</td>
<td>8 M</td>
<td>9 F</td>
<td>10 M</td>
<td>47 (38.85) 517.21</td>
</tr>
<tr>
<td>&gt;60</td>
<td>6 F</td>
<td>7 M</td>
<td>2 F</td>
<td>2 M</td>
<td>20 (16.53) 503.64</td>
</tr>
</tbody>
</table>

4 groups 121 (100) Mean (µm) 509.53

POAG, primary open angle glaucoma; OHT, ocular hypertension; CCT, central corneal thickness; M, males; F, females; Mean, middle values.

The CCT values in the OHT group, 529.37+/−25.18 µm, were greater than both CCT values of the POAG group, 501.02+/−14.04 µm, and CCT values of the control group, 497.37+/−14.90 µm. The IOP values in the OHT group were 20.25+/−3.62 mm Hg, while in the POAG group they were 18.25+/−2.7 mm Hg, compared to the control group, 13.53+/−3.62 mm Hg (Table 2). There was no relation between the diagnosis and sex of respondents; but the age group with patients aged over 60 showed statistical significance in the number of patients with POAG, OHT compared to the control group (p=0.011) (Table 1). Authors found a significant statistical difference was found (p=0.000) (Table 2) between respondents with OHT (value thickness corneal - 529.50 µm) and CCT of the control group (497.37 µm). The comparison of POAG mean value of CCT and control group of patients has shown the statistical difference (p=0.034), 501.02 µm and 497.37 µm, respectively. In patients with OHT, mean value of CCT (529.50 µm) and value of CCT for the group with the POAG (501.02 µm) was statistically different (p=0.000) (Table 2).

Table 2. Correlation of glaucoma types (ocular hypertension, primary open angle glaucoma and control group), means of intraocular pressure and means of central corneal thickness

<table>
<thead>
<tr>
<th>Glaucoma type</th>
<th>Mean IOP (mm Hg)</th>
<th>SD</th>
<th>Mean CCT (µm)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>OHT</td>
<td>40</td>
<td>20.25 mm Hg</td>
<td>1.81</td>
<td>529.37 µm</td>
</tr>
<tr>
<td>POAG</td>
<td>51</td>
<td>18.25 mm Hg</td>
<td>1.35</td>
<td>501.02 µm</td>
</tr>
<tr>
<td>Control group</td>
<td>30</td>
<td>13.53 mm Hg</td>
<td>1.81</td>
<td>497.37 µm</td>
</tr>
<tr>
<td>3 groups</td>
<td>121(100)</td>
<td>Σ 17.34 mm Hg</td>
<td>-</td>
<td>Σ 509.53 µm</td>
</tr>
</tbody>
</table>

OHT, ocular hypertension; POAG, primary open angle glaucoma; Mean IOP, middle values of intraocular pressure; Mean CCT, middle values of central corneal thickness; SD, standard deviation.

Mean value of IOP (20.25 mm Hg) in the patients with already established OHT diagnosis showed that IOP is one of the risk factors for progression of glaucoma. Mean value of IOP in patients with the POAG of 18.25 mm Hg was noticed. Mean value of IOP in the control group was 13.53 mm Hg (Table 2).

DISCUSSION

The results of this study have shown that 42.15% patients had primary open angle glaucoma, 33.06% ocular hypertension and 24.79% of the patients had the normal ophthalmological results. The CCT values in the OHT group were greater than both CCT values of the POAG group and CCT values of the control group. The IOP values of the OHT group were 20.25+/−3.62 mm Hg; POAG group values were 18.25+/−2.7 mm Hg; the control group values were 13.53+/−3.62 mm Hg. Analyses showed that there was a significant statistical difference in the disease distribution between genders, but the age group 46-60 showed a high prevalence of glaucoma. Mean value of IOP for all groups was within reference limits, which implies that the population investigated was under adequate clinical and therapeutic treatment. The question of adequacy of therapy used for the population with OHT disease remains open for the time being (3). Adequate monitoring and frequent controls remain the only solution for ophthalmologists, so the disease could cut off diagnoses in early stage. Clinical diagnosis for this study was set using morphological (optic nerve head) and functional (visual field) examinations, showing that CCT has influenced the adequate diagnosis of OHT and POAG, which is in agreement with other studies (2). Raised IOP is the causal risk factor for glaucoma that can be therapeutically manipulated to change the course of the disease progress and can use corneal pachymetry to help discover increased CCT, as another risk factor in the management of glaucoma disease (3, 4). The Goldman’s applanation tonometry is the “gold standard” for IOP measurements, used by domestic and international glaucoma experts (5). Determination of the CCT (500-555 µm) for each patient is necessary in contemporary managements of glaucoma disease, which was respected by authors while examining the patients (5).

In open angle glaucoma, a small, but significant increase in the average of stromal thickness was noticed in this study. This thickness increase was, in all likelihood, due to abnormal function of the endothelium in this disease since the level of IOP did not seem to be the dominant factor, but experience shows that it should not be underestimated as a risk factor (6).
The CCT must be considered when developing a treatment approach for the patients with OHT and POAG, as it is a known clinical suggestion (6, 7). Measured mean values of CCT suggest that there is a certain dependence of CCT and glaucoma (with measured IOP), but only, as some of the factors for the development of POAG and OHT, as confirmed by the ophthalmologists in this study (8, 9). In conclusion, the correlation between the Goldman’s applanation tonometry and the CCT has been investigated in many studies during the last four decades, as in this study (9). Determination of the CCT in glaucoma cases is crucial since it has an impact on the IOP values, measured with the applanation tonometer, which is an important parameter in diagnosing and follow up of POAG and OHT (9, 10). The mean CCT was higher for OHT and POAG than in the control group. CCT was estimated to have a clinically significant influence on IOP measurements in patients with POAG and OHT with the correction factor of IOP (each change in CCT for 10-20 µm, changes IOP values for 1 mm Hg) (9, 10). Ophthalmologists suggest that pachymetry results should be considered in the management of patients with OHT and glaucoma disease (10). The Corneal pachimetry is used in POAG and OHT for diagnosis and follow-up, and to establish a correlation between CCT and glaucoma progression. CCT is significantly higher in eyes with OHT than in those with POAG. In eyes with thin cornea the glaucoma progression tends to appear earlier, which suggests a need for lower target IOP for monitoring those patients (10). CCT is a confirmed risk factor for progression from OHT to POAG, and it is discussed whether CCT could have an inverse relation with the risk of developing glaucoma damage. Ophthalmologists claim that CCT measurement should be one of regular examinations in the treatment of glaucoma patients (11). Measurement of CCT is valuable for prognostic assessment of glaucoma, but not for correction factors for corneal thickness, as some author believed earlier, but today clinics cannot exclude the correctional factor, because of the fidelity of the results (12, 13). There was no significant difference in CCT between POAG patients and control group (India), but domestic experts did not share this opinion (14). In addition to the effect of thin, thick and normal corneas measured by Goldman’s applanation tonometer, as well as values of IOP and correction formulae are individual in eyes, which was also found by opthalmologic specialists (15). A Perspective for long-term studies needed if we wish to understand the disease better and help patients at greater risk of progression and blindness with our human and professional efforts (16). Besides the understanding of mechanism underlying the role of CCT as a risk factor for the development of glaucoma, it is also of an importance to understand how information about CCT should be used in clinical management of OHT and glaucoma disease and the actual question of glaucoma experts is whether other ocular properties should be measured to understand better individual risk profile of the patients (17).

In patients who have glaucoma diagnosed, IOP must be treated because it has an influence on progression of glaucoma, regardless of the baseline of IOP and CCT (18). Compared to Goldman’s applanation tonometer, IOP and CCT may be superior in the evaluation of glaucoma but are unlikely to represent effective diagnostic tests (19). The deficiency of this study may be in a potential subjective way of measuring values of CCT and IOP, use of adequate corrective factors, needs for a larger sample and time frame for follow-up of glaucoma disease. Novelties, guidelines and messages that may arise from this study in relation to present knowledge include the values of CCT as diagnostics and risk factors for monitoring of glaucomatous disease and other entities, which can be routine in clinical work with patients, but also a greater professional challenge for future researches.

FUNDING
No specific funding was received for this study.

REFERENCES


Evaluacija centralne kornealne debljine kod pacijenata s okularnom hipertenzijom i primarnim glaukomom otvorenog ugla

Mirjana A. Janićijević-Petrović1, Tatjana S. Šarenac-Vulović1, Katarina M. Janićijević2, Dejan A. Vulović2, Popović B. Andrijana2, Dragan I. Vujić³

1Klinika za oftalmologiju, Klinički centar Kragujevac u Kragujevcu; 2Fakultet medicinskih nauka Univerziteta u Kragujevcu; ³Državni univerzitet u Novom Pazaru; Srbija

SAŽETAK

Cilj: Cilj studije bio je određivanje korelacije između centralne kornealne debljine (CCT) i intraokularnog pritiska (IOP), meren aplanaciono, kod kontrolne grupe, pacijenata s primarnim glaukomom otvorenog ugla i s okularnom hipertenzijom.

Metode: Dvogodišnja retrospektivna studija dizajnirana je da odredi korelaciju između CCT-a i IOP-a. U studiju je bio uključen 121 pacijent. Kriteriji izbora i uključivanja svakog pacijenta bili su: IOP preko 22 mm Hg za grupu s okularnom hipertenzijom, bez funkcionalnih, morfoloških oštećenja i progresije bolesti; dijagnoza glaukoma za grupu s glaukomom otvorenog ugla i normalni oftalmološki nalazi za kontrolnu grupu. Pacijenti, monokulusi, sa sekundarnim glaukomima i s hirurškim tretmanima, bili su isključeni. Pacijenti su bili podeljeni u grupe prema tipu glaukoma, polu i starosnoj dobi. IOP vrednosti su merene Goldmannovim aplanacionim tonometrom, a CCT vrednosti su određivane upotrebom ultrazvučnog pahimetra u periodu od januara 2011. do decembra 2012. godine.

Rezultati: Od ukupno 121 ispitanika, 51 je imao primarni glaukom otvorenog ugla (POAG), 40 okularnu hipertenziju (OHT), a 30 u kontrolnoj grupi s normalnim oftalmološkim nalazima. Rezultati pokazuju da su vrednosti CCT-a u grupi s OHT om (529.37+/–25.18 µm) bile veće nego vrednosti CCT-a u grupi s POAG om (501.02+/–14.04 µm), te u kontrolnoj grupi (497.37+/–14.90 µm). Vrednosti IOP-a u grupi s OHT om bile su 20.25+/–3.62 mm Hg, u grupi s POAG om 18.25+/–2.70 mm Hg, a kod kontrolne grupe 13.53+/–3.62 mm Hg.

Zaključak: Određivanje CCT-a kod pacijenata s glaukomom bitan je faktor pri merenju IOP-a, koji predstavlja dijagnostički parametar za praćenje progresije okularne hipertenzije i dijagnostikovanog glaukoma.

Ključne reči: glaukoma bolest, Goldmannov tonometar, ultrazvučni pahimeter