THE IMPACT OF CENTRAL CORNEAL THICKNESS ON INTRAOCULAR PRESSURE AS SEEN IN PATIENTS PRESENTING TO DR GEORGE MUKHARI HOSPITAL

by

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DISSERTATION

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SUPERVISOR: Dr B Matlala
DECLARATION

I declare that The impact of central corneal thickness on intraocular pressure as seen in patients presenting to Dr George Mukhari Hospital (dissertation) hereby submitted to the Sefako Magkatho University for the degree of Master of medicine in Ophthalmology has not previously been submitted by me for a degree at this or any other university; that it is my own work in design and in execution, and that all material contained herein has been duly acknowledged.

Dr. Tshilidzi Hulisani Nthangeni																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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Firstly I would like to thank God, my Lord and Father for providing me with my gifts, passions, and motivations.

I would also like to thank my husband and parents for their love and support.

Lastly, I thank my supervisor Dr Matlala for his guidance throughout my years of specializing.
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ABSTRACT

Background: Central corneal thickness is an important measurement in different aspects of ophthalmology. One example is its relevance in Goldmann applanation tonometry (GAT), the accepted gold standard for the estimation of intraocular pressure. Intraocular pressure is an important risk factor in the diagnosis and management of glaucoma patients. However, early studies have highlighted that the accuracy of GAT is dependent on an assumed central corneal thickness (CCT) measurement of 520 micrometres. Some studies suggest that a significant deviation from this amount may lead to an underestimation or overestimation of the IOP. The consequence of which would be the under-diagnosis and under-treatment of patients suspected to have glaucoma.

Aim of the study: To determine whether the central corneal thickness is reduced in patients seen at the Dr George Mukhari eye clinic, and if this reduction has an impact on the intraocular pressure measurement of these patients.

Methods: A total of 300 patients (600 eyes), were included in this prospective descriptive study. The Medunsa Research and Ethics Committee (MREC) had approved the study. Consecutive patients presenting for the first time to the Dr George Mukhari eye clinic were randomly selected for investigation. The intraocular pressure was measured by GAT and central corneal thickness by optical coherence tomography. The formula by Ehlers was used to adjust the GAT reading for CCT measurements that deviated from the value of 520 micrometres by more than 10 micrometres. The data regarding demographic information and these variables was interpreted using SAS Release 9.2.

Results: The age group of the participants ranged from 18 to 90 years. A mean CCT measurement of 506.2 um and 505.6 um (right and left eyes respectively)
was found. Based on the CCT measurement 247 (82.3%) and 252 (84%) (right and left eyes respectively), participants required an adjustment of their IOP. The adjustment in the majority (69.2% and 73.8% respectively), resulted in an increase in the measured IOP. A significant number of patients (p<0.0001) had an elevated IOP after adjustment compared to before adjustment. There was no correlation between the measured CCT and IOP readings ($R^2 = 0.0197$; $p=0.9705$ and $R^2 = 0.2721$; $p=0.6019$ for right eyes, and $R^2 = 0.0102$; $p=0.9847$ and $R^2 = 0.1413$; $p=0.7895$ for left eyes).

**Conclusion:** The findings confirm the presence of thinner CCT measurements in black participants. It is in keeping with international and African studies in other black population groups. The thinner corneas influenced the GAT reading, and resulted in significantly more patients having an elevated IOP (>21 mmHg). CCT is an important measurement in patients presenting to our facility. Its routine documentation may provide for a better estimation of the IOP, the early diagnosis of glaucoma, and a more reliable classification of patients suspected to suffer from glaucoma.
CHAPTER I: INTRODUCTION

The focus of this research was to determine the impact, if any, of central corneal thickness on the intraocular pressure in patients presenting to the Dr George Mukhari Hospital eye clinic. The two variables measured were central corneal thickness and intraocular pressure. The need for intraocular pressure to be adjusted based on the central corneal thickness was assessed. This chapter introduces the background that served as a motivation for the study. In addition, it describes the research questions, research purpose, and the research objectives.

1.1 BACKGROUND OF THE STUDY

Central corneal thickness (CCT) is a measurement that is useful in many different aspects of ophthalmology. It is an important factor in refractive surgery, the monitoring of disease progression in certain ocular conditions, the diagnosis of certain ocular conditions, and the use of certain instruments (1). The Goldmann Applanation Tonometer (GAT) is one important instrument that uses CCT to estimate the intraocular pressure (IOP) of the eye (1). It is the instrument used most often at the Dr George Mukhari eye clinic to measure IOP. This instrument assumes a certain CCT measurement for accuracy, which was discovered in studies performed in predominantly white population groups (2). Several studies, as will be mentioned in the literature review, have demonstrated a reduced CCT in black population groups. Studies have gone on to reason that if a person's CCT were less than the assumed value, their intraocular pressure would be underestimated by the GAT. Similarly, that an increased CCT measurement would result in an overestimation of the IOP (2,3). This has an important implication specifically for glaucoma, a common cause of irreversible blindness worldwide (4). The concern underlying this study was the possibility that this condition may be under-diagnosed or under-treated in patients seen at this facility, due to the error in IOP measurement.
No other studies have been done to measure and document central corneal thickness values in the predominantly black population group seen at the Dr George Mukhari eye clinic. If these patients were found to have a significantly reduced CCT measurement, this would serve to encourage the necessity of routinely documenting this value in the patients seen at this facility.

1.2 RESEARCH AIM

The aim of this research is to determine whether the central corneal thickness is reduced in patients seen at the Dr George Mukhari eye clinic, and if this reduction has an impact on the intraocular pressure measurement of these patients.

1.3 RESEARCH QUESTIONS

The study was designed to answer two main questions, which are as follows:

1. Do patients seen at Dr George Mukhari Hospital have a reduced central corneal thickness, as demonstrated in other black population groups?
2. If the central corneal thickness is reduced, does it significantly change the measured intraocular pressure in our study population?

1.4 RESEARCH OBJECTIVES

1. To measure the central corneal thickness in the sample population.
2. To measure intraocular pressure in the sample population.
3. To statistically determine the proportion of patients who require intraocular pressure adjustment based on their central corneal thickness measurement.
CHAPTER II: LITERATURE REVIEW

2.1 CENTRAL CORNEAL THICKNESS

2.1.1 Definition

The central corneal thickness (CCT) is defined as the thickness in the central part of the cornea, a structure that forms the anterior one 6th of the eye (5). The normal CCT in humans ranges from 500-600 micrometres (5).

2.1.2 Factors associated with variability

The CCT value can vary depending on several different factors. These factors include: race, age, gender, and ocular comorbidities (6).

2.1.2.1 Race

Several studies have documented the CCT value in different racial groups. A meta-analysis of the literature regarding CCT reviewed more than 300 articles documenting CCT measurements (6). They found that the CCT was significantly thinner in the African American, Mongolian, and Indian participants, with mean values less than 530 micrometres. This was in comparison to Caucasian, Hispanic, Asian, and European participants.

A study performed in the United States reported differences in the CCT of the various racial groups within that population (7). The 2,479 participants consisted of Caucasians, African Americans, Asians, and Hispanics. They found that African Americans had significantly thinner corneas than the other racial groups. Other studies have confirmed the finding of thinner CCT measurements in black participants compared to their Caucasian counterparts (8,9,10).

Several studies have also reported CCT measurements in African populations. One such study found that patients of North African origin had a significantly
thinner CCT when compared to those of American, European, Asian, and Israeli origins (11). Another publication reviewed the literature regarding CCT measurements in Sub-Saharan Africa (12). The countries examined included Nigeria, Ghana, Cameroon, Ethiopia, and South Africa. They found mean CCT values that varied from 512 -550 micrometres, with the thinnest mean CCT values found in the South African participants. The studies, however, included non-glaucomatous and glaucomatous participants, and varied significantly in sample size.

The variation in CCT in different races has also been noted in the South African population. A study published in 2012, conducted in Kwa-Zulu Natal found that black participants had thinner CCT values when compared to Indian participants (13). Another study conducted in the Free State compared the CCT of black, white, and coloured South Africans (14). They also found that the black participants had the thinnest mean CCT when compared to the other racial groups. In addition, they noted that the mean CCT found in the black participants was lower than the mean reported in other major international population based studies.

2.1.2.2 Age

In a multicentre study, the Paediatric Eye Disease Investigator Group recorded the mean CCT values of 2079 children (15). They found that African American children had significantly thinner corneas at all ages when compared to white and Hispanic children. They, along with other studies (15,16), found that the CCT value increases with age.

Other studies have reported that the mean CCT decreases with age. A study performed on 1,650 Caucasian Lithuanian adults published that older patients had thinner corneas (17). Another study performed in a Cameroonian population had similar findings. They examined 970 eyes and reported that CCT decreased
by 4.2 micrometres for every 10 years of life. In addition, the participants under the age of 20 were found to have the thickest corneas (18). The Reykjavik study, which examined Caucasian patients between the ages of 50-85 years, found the CCT to be independent of the age of participants (19).

2.1.2.3 Gender

Several studies have documented the relationship between gender and CCT. The Beijing Eye Study published in 2008 included 3,251 participants. They along with another study conducted in a Japanese population found a correlation between gender and CCT. They both found the CCT to be thicker in males (20,21). Other studies found no correlation between the two factors. The studies mentioned previously that were performed in Lithuanian and Cameroonian populations found no correlation between the gender and CCT (17,18).

2.1.2.4 Ocular Conditions

Ocular hypertension is defined as a condition in which the measured intraocular pressure is higher (>21mm of mercury) than expected according to population statistics for normal intraocular pressure (1). The Ocular Hypertension Treatment study (OHTS) was a landmark ophthalmological study with findings published in 2001 (22). In this study CCT was found to be a predictor for the development of primary open angle glaucoma (POAG) in patients with ocular hypertension. Patients with a CCT of 555 micrometres or less had a 3 fold greater risk when compared to those with a CCT of 558 or greater. A subsequent study published in 2012 used data from the OHTS to determine whether CCT could indeed be regarded as independent risk factor for the development of POAG. The authors concluded that it could not, and emphasized the need for further investigation (23). Other studies have highlighted the finding of a thicker CCT in patients with ocular hypertension (24,25).
Normal tension glaucoma (NTG) is a type of open angle glaucoma characterized by a normal intraocular pressure (IOP), glaucomatous disc damage (in the absence of secondary causes of such damage), glaucomatous visual field loss, and an open angle on gonioscopy (26). A study published in 1998 found that the CCT was reduced in patients with NTG (27). A subsequent study published in 1999 investigated the effect CCT in patients with ocular hypertension, NTG, and primary open angle glaucoma (POAG). Those with ocular hypertension demonstrated an increased CCT and were at risk of an overestimation of their IOP compared to those with POAG. Those with NTG demonstrated a decreased CCT and were at risk of an underestimation of their IOP when compared to those with POAG. The effect in both instances was noted to be a misdiagnosis of the patients (28).

Primary open angle glaucoma (POAG) is the most common form of glaucoma (1). The defining characteristics are similar to those of NTG, except for the presence of a raised intraocular pressure. A study published in 2004 retrospectively reviewed the clinical information of 190 patients with this diagnosis (29). They found a lower CCT measurement to be a significant predictor of glaucoma severity at the time of presentation. In addition they recommended that CCT was a measurement that could assist in identifying patients at higher risk of progression.

2.1.3 Measurement of central corneal thickness

Various methods are available for the measurement of CCT. The older methods include specular microscopy and confocal microscopy. Newer methods include the ultrasound pachymeter, optical coherence tomography (OCT), and optical non-contact scanning slit methods (orbscan and pentacam) (30,31,32). Currently the ultrasound pachymeter is considered the gold standard tool for measuring CCT (33). It offers better intersession repeatability and interobserver variation when compared to older methods (34). However, this is a contact method often
associated with other problems which may affect its accuracy. These include the necessity of topical anaesthesia, the need for the accurate placement of the probe on the cornea, and the risk of damage to the cornea (34). Several studies have compared the accuracy of the ultrasound pachymeter to OCT. One study compared the CCT measurement made by 3 different examiners on 70 eyes, using both methods. The conclusion was that the measurements obtained by both methods were comparable and OCT could be used as an alternative for CCT measurement (33). Another study however found that OCT had higher interexaminer reproducibility, but tended to underestimate the CCT value (28). OCT also has the advantage of being a non-contact method, therefore, removing the necessity for topical anaesthesia and the risk of damage to the cornea (33).

2.2 GLAUCOMA

Glaucoma is the second most common cause of blindness (4). It is a term that encompasses a group of disorders resulting in a characteristic optic neuropathy and visual field loss, in which raised intraocular pressure is usually a treatable risk factor (35). In 2013 the number of estimated glaucoma patients worldwide was reported to be 64.3 million, with blindness in an estimated 4.5 million people (4,36). Its detection is hampered by the silent progressive nature of the disease, especially in the early stages. As a result it is estimated that as many as 50 per cent of individuals in developed countries with the disorder are unaware of their diagnosis (37). Due to problems of access to health care and education, this figure is presumably higher in developing countries. A review of the literature highlighted the higher prevalence, earlier onset, and more rapid progression of POAG in black individuals (38). As raised intraocular pressure is a treatable factor, its measurement and monitoring forms an important part of the management of patients with glaucoma (39).

2.3 INTRAOCULAR PRESSURE
2.3.1 Definition

Intraocular pressure (IOP) is the pressure exerted by the fluids inside the eye (40). The normal range is 11-21 millimetres of mercury (mmHg), with a mean of 16 mmHg (25).

2.3.2 Diurnal variation of intraocular pressure

Diurnal variation refers to the change in intraocular pressure throughout the course of the day, linked to the circadian regulation of aqueous humour production (41). Individuals have their own unique 24-hour IOP pattern (42). Typically in healthy patients the measured IOP is higher at night than during the day (42). This variation may average up to 5 mm of mercury in healthy patients (42).

2.3.3 Impact of central corneal thickness on intraocular pressure

Several studies have documented findings regarding the correlation between CCT and IOP. A study performed in African American glaucomatous and nonglaucomatous participants reported a positive correlation between decreased CCT and the measured IOP (8). Another study in a review of the literature highlighted that about 50-60% of ocular hypertensives have a normal IOP reading, while 30-40% of NTG patients actually have a raised IOP (7). Other studies conducted in Caucasians, Asians, Hispanics, Ethiopians confirmed the finding of a positive correlation between the two factors (7, 43).

The Barbados Eye Study that published its findings in 2003 did not find a correlation between CCT and IOP (10). Although it concluded that the black participants had thinner corneas, it did not find this to correlate with the
measured IOP. They however postulated that confounding factors might have been responsible for the higher mean IOP readings.

2.4 GOLDMANN APPLANATION TONOMERY

2.4.1 Principles of use

The Goldmann applanation tonometer (GAT) is considered the gold standard for the measurement of IOP and assumes a CCT of 520 micrometres for accuracy (43). The functioning of the GAT is based on the Imbert–Fick principle. This principle states that the amount of force that is needed to applanate a perfect infinitely thin dry sphere, divided by the flattened area, equals the pressure inside the sphere \( P = \frac{F}{A} \). Importantly, the tonometer head is positioned so as to flatten the central 3.06mm of the cornea (1). It has been reported that this instrument measures an artificially low IOP in thinner corneas and an artificially high IOP in thicker corneas (5,22,28). It is the instrument used at the Dr George Mukhari eye clinic to measure IOP.

2.4.2 Adjustment for central corneal thickness

A cross sectional retrospective study of 188 glaucoma suspects and glaucoma patients was published in 2004. This study corrected for the IOP obtained on GAT, based on the CCT measurement. Changes of treatment in adjusted cases were noted, which highlighted the significant effect of CCT adjusted IOP on the clinical management of the participants (44). Another study was performed in a general ophthalmic clinic in England. It confirmed the relevance of CCT measurement with the adjustment of IOP in the classification of patients at risk of glaucoma (45). An additional study published that relying on an unadjusted GAT reading may result in patients being misdiagnosed and mismanaged (7).
Several studies have investigated the use of correction formulas for adjusting the IOP based on the CCT. An early IOP correction formula was described in 1975 (2). This study published a statistically significant correlation between the CCT and the error in the IOP based on GAT. It determined that the average error caused by a 10 micrometre deviation of the CCT from the normal value of 520 micrometres, corresponds to an intraocular pressure difference of 0.7 mmHg. The linear relationship between these variables resulted in the formation of a correction table to determine the IOP from the GAT reading and the CCT. Other proposed linear correction formulas have been a 0.5mmHg and 0.6mmHg correction for every 10 micrometre deviation in CCT (6,46). A more recent study published in 2004 adjusted the IOP using both a linear and mathematical algorithm (44). It found the final adjusted value to be similar regardless of the formula used.

However there are also studies that have questioned the need for IOP adjustment. One such study that published its findings in 2005 found that there was no linear correlation between CCT and the GAT reading (47). It, therefore, concluded that a simple correction formula for adjustment might not be appropriate. This was supported by a subsequent study, which concluded that the use of adjustment formulae was more suitable for population analysis than for individuals in the clinical setting (48).
CHAPTER III: METHODOLOGY

The methodology used in the study will be outlined under the following headings: study design, study setting, study population and sample size. The data collection, data analysis, reliability, validity, and ethical considerations of the study have also been discussed.

3.1 STUDY DESIGN

The study was a prospective descriptive study of consecutive patients who presented to the Dr George Mukhari eye clinic, and met the inclusion criteria. The descriptive design was used for this study, as it was the most appropriate design to collect information relevant to the research objectives. The study was conducted over a four-month period: from 1/11/14 to 20/2/15. This followed the approval of the study protocol by Medunsa Research and Ethics Committee. A structured questionnaire was used for the purpose of the study (Appendix A).

3.2 STUDY POPULATION AND SETTING

The study was conducted at the Dr George Mukhari eye clinic. This is a tertiary facility located within Pretoria in South Africa. This facility receives referrals from three provinces in South Africa namely Gauteng, Limpopo and the North West. The study population consisted of adult male or female patients, who had been referred to the eye clinic. Any such patient who presented to the facility from Monday to Friday (8am to 4pm) during the study period was potentially eligible to participate in the study. Children were excluded because of the difficulty of obtaining the measurements with the instruments used.

3.3 STUDY SAMPLE AND SIZE

A sample of 300 patients (600 eyes) was used in the study. This was according to an estimation done on the nQuery Advisor Release 7.0 program. This was
obtained by simple random sampling, which gave eligible patients an equal opportunity of being selected to participate in the study. Information regarding the study was communicated in the language preferred by the patient. A patient was only included in the study when they had given informed consent. However, it was made clear to patients who refused to participate in the study that the health care they received would not be compromised.

Inclusion criteria:
- Age of 18 years or older
- Male and female gender
- Black race
- Both eyes present

Exclusion criteria:
- Current use of topical, oral, or systemic steroids
- History of previous ocular trauma
- History of previous ocular surgery
- A known diagnosis of glaucoma
- The presence of ocular surface and corneal disease

3.4 DATA COLLECTION INSTRUMENTS AND PROCEDURE

Patients who were to be included in the study were initially given an information leaflet summarizing the background of the study (Appendix B). A structured questionnaire with closed ended questions was designed to answer the learning objectives. The questions were verbally communicated to the patient and filled in by the principal researcher. The demographic information included age, race, gender, and the current residence. The clinical information included central corneal thickness (CCT) and intraocular pressure (IOP) from both eyes. Measurements were obtained on both eyes from 300 patients.
The IOP was measured using the Goldman applanation tonometer. This was preceded by the instillation of a topical anaesthetic and a fluorescein solution into the eyes. Initial readings were taken, and subsequent readings were taken one minute later. The average of the two readings from each eye respectively was then calculated. The optical coherence tomography (Cirrus HD OCT, Spectral domain technology) was used to obtain a single CCT measurement from each eye. All of the measurements and the documentation of the data were performed by the principal researcher. All of the patients who had been initially invited to participate in the study had their data analysed.

3.5 DATA ANALYSIS

The data was coded and entered on an excel spreadsheet. The researcher in consultation with a statistician analysed the data. The statistical procedures were performed on SAS Release 9.2, running under Microsoft Windows for a personal computer. The demographic information was summarized descriptively. Basic statistics (mean, standard deviation, median, minimum, maximum values) were determined for the IOP and CCT. The percentage of patients requiring IOP adjustment was calculated from the sample with a 95% confidence interval. The equation by Ehlers \{\text{adjusted IOP} = \text{measured IOP} - 5.0 \times \left( \frac{\text{CCT}}{1000} - 0.520 \right)/0.070 \} (2) as discussed in the literature was used to make the adjustment. An adjustment of the intraocular pressure was performed for all eyes with a central corneal thickness that was 10 micrometres or more from the value of 520 micrometres. The Ehlers correction formula was selected because it is the formula currently used at the Dr George Mukhari eye clinic. Pearson’s correlation coefficient was used to calculate the relationship between central corneal thickness and intraocular pressure. The closer the correlation coefficient is to 1.0, the stronger the relationship between the two variables. The statistical tests were two sided and a p value of less than or equal to 0.05 was considered significant.

3.6 RELIABILITY AND VALIDITY
A single Goldman applanation tonometer was used for intraocular pressure measurement in all the participants. As mentioned in the literature review this is considered the gold standard for intraocular pressure measurement. Calibrating it prior to its use in the study optimized the reliability of the instrument. Intraocular pressure measurements were repeated for each eye. The principal researcher obtained all the measurements. Although the measurements are non-invasive, the cooperation of the patient was required to ensure accuracy. In order to facilitate this, careful instructions were given to the patients. The validity of the measurements was improved by adhering to the exclusion criteria previously mentioned.

3.7 BIAS

Various strategies were employed to help minimize bias. They included:

- The measurement of intraocular pressure only between 8am and 4pm, took into consideration the diurnal variation of the intraocular pressure as mentioned in the literature review.
- The simple random sampling method already described served to minimize selection bias.
- The measurements obtained were objective and not easily influenced by the participants.

3.8 ETHICAL CONSIDERATIONS

Various considerations were made in order to conduct the research in an ethical manner and they included the following:

- A clearance certificate was obtained from the Medunsa Research and Ethics committee before commencing the study (Appendix C).
was also obtained from the medical superintendent of Dr George Mukhari Hospital to conduct the study.

- Written informed consent was obtained from all the participants of the study. This was available in different languages (Appendix D). All of the information included was culturally and religiously sensitive. The information obtained from the patients was only used for the purpose of the study.
- All participants were assured that the information they provided would be kept confidential. Research numbers were assigned to the questionnaires, and only the principal researcher could identify which number belonged to which participant.
- The routine assessment and management of the participants was not compromised throughout the course of the study.
CHAPTER IV: RESULTS

This chapter presents the findings from the analysis of the data collected during this study. Three hundred pairs of eyes were examined. The right and left eyes were analysed separately for statistical purposes. The results include descriptive information regarding the demographics, as well as the statistical analysis of the CCT and IOP.

4.1 DEMOGRAPHIC CHARACTERISTICS OF THE STUDY POPULATION

The age of the participants enrolled in the study ranged from 18 to 90 years, with a mean ± standard deviation of 56.0 ± 16.3 years as shown in Table 4.1. Female participants were predominant in the series and accounted for 62.7%, while male patients made up 37.3% of the total study population. The majority of patients (69.0%) were referred from the Gauteng province, 28.3% came from the North West province, three patients (1.0%) came from the Limpopo province and the remaining 5 patients listed as “others” came from the Democratic Republic of Congo (DRC), Kwa-Zulu Natal, Mpumalanga and Zimbabwe.

TABLE 4.1: DEMOGRAPHIC FEATURES OF THE STUDY PARTICIPANTS

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<th>Number</th>
<th>Percentage of patients</th>
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<td>Range</td>
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<tr>
<td>Mean</td>
<td>56.0</td>
<td>-</td>
</tr>
<tr>
<td>SD</td>
<td>16.3</td>
<td>-</td>
</tr>
<tr>
<td>Median</td>
<td>58.0</td>
<td>-</td>
</tr>
<tr>
<td><strong>GENDER:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>188</td>
<td>62.7</td>
</tr>
<tr>
<td>Males</td>
<td>112</td>
<td>37.3</td>
</tr>
<tr>
<td><strong>Residence</strong> (Province):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gauteng</td>
<td>207</td>
<td>69.0</td>
</tr>
<tr>
<td>North West</td>
<td>85</td>
<td>28.3</td>
</tr>
<tr>
<td>Limpopo</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>Others</td>
<td>5</td>
<td>1.7</td>
</tr>
</tbody>
</table>
4.2 STATISTICAL CHARACTERISTICS OF CENTRAL CORNEAL THICKNESS AND INTRAOCULAR PRESSURE

Table 4.2 shows the results of the initial assessment of the CCT and IOP of the participants. The CCT ranged from 176 – 604 in the right eyes and 396 – 616 in the left eyes. There was a mean ± standard deviation of 506.2 ± 41.3 for the right eyes, and 505.6 ± 37.2 for the left eyes. The difference between the two was not statistically significant (p = 0.8518). The IOP ranged from 7-46 in the right eyes and 7-50 in the left eyes. Similar findings were recorded for IOP in which the mean ± standard deviation for right eyes was 15.9 ± 4.9, and 16.0 ± 5.3 for the left eyes. The difference between the values was not statistically significant (p = 0.7720).

**TABLE 4.2: INITIAL ASSESSMENT OF CCT AND IOP IN STUDY PARTICIPANTS [N = 300]**

<table>
<thead>
<tr>
<th></th>
<th>Right Eye</th>
<th>Left Eye</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Central Corneal Thickness:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>176 – 604</td>
<td>396 – 616</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>506.2</td>
<td>505.6</td>
<td>0.8518</td>
</tr>
<tr>
<td>SD</td>
<td>41.3</td>
<td>37.2</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>504.0</td>
<td>504.0</td>
<td></td>
</tr>
<tr>
<td><strong>Intra-Ocular Pressure:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>7.0 – 46</td>
<td>7.0 – 50.0</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>15.9</td>
<td>16.0</td>
<td>0.7720</td>
</tr>
<tr>
<td>SD</td>
<td>4.9</td>
<td>5.3</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>15.0</td>
<td>15.0</td>
<td></td>
</tr>
</tbody>
</table>

Key: SD = Standard Deviation
4.3 THE NEED FOR IOP ADJUSTMENT BASED ON CCT

The IOP was adjusted for the CCT based on a deviation of 10 micrometres or more from the value of 520 micrometres. As mentioned in the literature review, 520 micrometres is the assumed CCT for accurate GAT. The need for the correction of the IOP based on the CCT is shown in Figure 4.1 (right eyes) and Figure 4.2 (left eyes). Among the patients in the study, 247 (82.3%) needed correction for CCT in right eyes and this compared with 252 (84.0%) who needed correction for CCT in the left eyes.

![Figure 4.1: Number of right eyes requiring correction for CCT](image1)

![Figure 4.2: Number of left eyes requiring correction for CCT](image2)
Out of the 247 right eyes that needed correction, 76 eyes (30.8%) were for a decrease in IOP while 171 (69.2%) were for an increase in IOP (see Table 4.3). For those who needed correction of the IOP in left eyes (252 patients), 66 (26.2%) were for a decrease in IOP and 186 (73.8%) were for an increase in IOP. The difference in the correction needed for right eyes and for left eyes was not statistically significant for either the decrease in IOP (p = 0.6111) or increase in IOP (p = 0.7438). The final mean IOP after correction was 16.88 ± 5.20 (right eyes) and 17.06 ± 5.56 (left eyes). The difference in the two was not statistically significant (p = 0.6824).

The number of patients with an IOP >21mmHg before and after correction is indicated in Table 4.3. Before correction, 25 right eyes (8.3%) and 24 left eyes (8.0%) had an IOP > 21mmHg. This compares to 38 right eyes (12.7%) and 41 left eyes (13.7%) after correction. The difference in the number of patients before (p=0.7780) and after (p=0.5236) correction for the right and left eyes respectively is also noted. This difference was not statistically significant. However, for the participants with an IOP >21mmHg (right eyes) the difference between the number of participants before correction and after correction was statistically significant (p<0.0001). This was similar to the left eyes (p<0.0001).
TABLE 4.3: DETAILS OF THE CORRECTION OF IOP PERFORMED FOR BOTH RIGHT AND LEFT EYES

<table>
<thead>
<tr>
<th></th>
<th>Right Eyes</th>
<th>Left Eyes</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of eyes Corrected</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Need for decrease in IOP</td>
<td>247 (82.3%)</td>
<td>252 (84.0%)</td>
<td>0.6111</td>
</tr>
<tr>
<td>- Need for increase in IOP</td>
<td>76 (30.8%)</td>
<td>66 (26.2%)</td>
<td>0.7438</td>
</tr>
<tr>
<td></td>
<td>171 (69.2%)</td>
<td>186 (73.8%)</td>
<td></td>
</tr>
<tr>
<td>Final IOP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>8.04 – 41.52</td>
<td>8.88 – 51.68</td>
<td>0.6824</td>
</tr>
<tr>
<td>Mean</td>
<td>16.88</td>
<td>17.06</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>5.20</td>
<td>5.56</td>
<td></td>
</tr>
<tr>
<td>Number of patients with IOP &gt; 21.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Before correction</td>
<td>25 (8.3%)</td>
<td>24 (8.0%)</td>
<td>0.7780</td>
</tr>
<tr>
<td>- After correction</td>
<td>38 (12.7%)</td>
<td>41 (13.7%)</td>
<td>0.5236</td>
</tr>
<tr>
<td>p-value</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
</tbody>
</table>

The results from the study were stratified for different age groups and gender in relation to CCT and IOP (Table 4.4, 4.5, 4.6). This was done in order to evaluate the impact of age and gender on either CCT or IOP. Similar values for CCT (right and left eyes respectively) were found for the different age groups. The mean (± standard deviation) IOP readings were also similar for the different age groups. The difference in the mean (± standard deviation) CCT measurement between the genders was not statistically significant (p=0.4529 and p=0.6565).
TABLE 4.4: STRATIFICATION OF CCT AND IOP FOR DIFFERENT AGE GROUPS AND GENDER

<table>
<thead>
<tr>
<th>Stratifications of results</th>
<th>Right Eyes</th>
<th></th>
<th>Left Eyes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>Mean CCT</td>
<td>SD</td>
</tr>
<tr>
<td>Age distribution &amp; CCT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 20 yrs.</td>
<td>3</td>
<td>1.0</td>
<td>555</td>
<td>28</td>
</tr>
<tr>
<td>20 – 39</td>
<td>46</td>
<td>15.3</td>
<td>496</td>
<td>63</td>
</tr>
<tr>
<td>40 – 59</td>
<td>114</td>
<td>38.0</td>
<td>511</td>
<td>36</td>
</tr>
<tr>
<td>≥ 60</td>
<td>137</td>
<td>45.7</td>
<td>505</td>
<td>35</td>
</tr>
<tr>
<td>Age distribution &amp; IOP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 20 yrs.</td>
<td>3</td>
<td>1.0</td>
<td>16.0</td>
<td>1.0</td>
</tr>
<tr>
<td>20 – 39</td>
<td>46</td>
<td>15.3</td>
<td>15.2</td>
<td>3.7</td>
</tr>
<tr>
<td>40 - 59</td>
<td>114</td>
<td>38.0</td>
<td>16.3</td>
<td>5.2</td>
</tr>
<tr>
<td>≥ 60</td>
<td>137</td>
<td>45.7</td>
<td>15.7</td>
<td>5.2</td>
</tr>
<tr>
<td>Gender &amp; CCT:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>188</td>
<td>62.7</td>
<td>508</td>
<td>36</td>
</tr>
<tr>
<td>Males</td>
<td>112</td>
<td>37.3</td>
<td>504</td>
<td>49</td>
</tr>
<tr>
<td>p-value</td>
<td></td>
<td></td>
<td>0.4529</td>
<td></td>
</tr>
</tbody>
</table>

The impact of the age on CCT and IOP was evaluated (Table 4.5 and 4.6). For this purpose patients were stratified into two age groups: (1) < 20 years of age and (2) patients 20 years or older. The mean CCT for patients <20 years was higher than the measured value in patients ≥ 20 years. This difference was statistically significant for both the right and left eyes (p-value: 0.0161 and p-value: 0.0067). In contrast, the mean IOP for patients <20 years and those ≥ 20 years had a difference that was not statistically significant for both eyes (p = 0.8967 and p = 0.5896).
TABLE 4.5: EFFECT OF AGE OF PATIENTS ON CENTRAL CORNEAL THICKNESS: RIGHT AND LEFT EYES

<table>
<thead>
<tr>
<th>Age of patients</th>
<th>Right Eye CCT [Mean ± SD]</th>
<th>Left Eye CCT [Mean ± SD]</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20 years old (N = 3)</td>
<td>555 (± 28.4)</td>
<td>556 ± 26.2</td>
</tr>
<tr>
<td>≥ 20 years old (N = 298)</td>
<td>506 (± 41.2)</td>
<td>505 (± 36.9)</td>
</tr>
<tr>
<td></td>
<td>p-value: 0.0161</td>
<td>p-value: 0.0067</td>
</tr>
</tbody>
</table>

TABLE 4.6: EFFECT OF AGE OF PATIENTS ON INTRAOCULAR PRESSURE: RIGHT AND LEFT EYES

<table>
<thead>
<tr>
<th>Age of patients</th>
<th>Right Eye IOP [Mean ± SD]</th>
<th>Left Eye IOP [Mean ± SD]</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20 years old (N = 3)</td>
<td>16.0 (± 1.0)</td>
<td>17.0 (± 2.6)</td>
</tr>
<tr>
<td>≥ 20 years old (N = 298)</td>
<td>15.9 (± 4.7)</td>
<td>16.0 (± 5.3)</td>
</tr>
<tr>
<td></td>
<td>p-value: 0.8967</td>
<td>p-value: 0.5896</td>
</tr>
</tbody>
</table>

4.4 CORRELATION OF CENTRAL CORNEAL THICKNESS AND INTRAOCULAR PRESSURE

An evaluation of whether CCT is correlated with IOP or whether each variable is independent of the other was made by calculating Pearson’s Correlation Coefficient (PCC). The results are shown in Table 4.7 below. The correlation ($R^2$) between two sets of data is a measure of how strongly related they are. The result of PCC always lies between (-1) when negatively correlated and (+1) when positively correlated. The closer to 1.0 the value of PCC is, the stronger the relationship between the two variables. The CCT in relation to IOP yielded no statistically significant difference between the CCT of the right eyes and the IOP of the right eyes (Pearson’s Correlation Coefficient ($R^2$) = 0.1951; $p = 0.7111$).
Similar findings were recorded when the PCC was calculated for the relationship between the CCT and IOP of the left eyes with correlation coefficient \((R^2) = 0.1343\) and \(p = 0.7998\). Results were also stratified for patients with normal CCT (520 – 600) and against those with CCT < 520. Each group was evaluated for its relationship with IOP.

Patients with CCT of 520-600 calculated for a relationship with IOP, yielded a correlation coefficient of \(R^2 = 0.2721; p = 0.6019\) (right eyes versus IOP) and \(R^2 = 0.1413; p = 0.7895\) (left eyes versus IOP). The same calculations were made for those patients with a CCT < 520. The results show (as in Table 4.7) the correlation coefficient for right eyes versus IOP to be \(R^2 = 0.0197\) \((p = 0.9705)\) and for left eyes versus IOP to be \(R^2 = 0.0102\) with \(p = 0.9847\).

### TABLE 4.7: PEARSON'S CORRELATION COEFFICIENT (PCC) FOR CCT AND IOP

<table>
<thead>
<tr>
<th>Variables for Pearson's Correlation Coefficient</th>
<th>PCC ((R^2))</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right-CCT versus Right-IOP</td>
<td>(R^2 = 0.1951)</td>
<td>0.7111</td>
</tr>
<tr>
<td>Left-CCT versus Left-IOP</td>
<td>(R^2 = 0.1343)</td>
<td>0.7998</td>
</tr>
<tr>
<td>Patients with Normal CCT [520 – 600] vs IOP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right-Eyes vs IOP</td>
<td>(R^2 = 0.2721)</td>
<td>0.6019</td>
</tr>
<tr>
<td>Left-Eyes vs IOP</td>
<td>(R^2 = 0.1413)</td>
<td>0.7895</td>
</tr>
<tr>
<td>Patients with Abnormal CCT [&lt; 520] vs IOP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right-Eyes vs IOP</td>
<td>(R^2 = 0.0197)</td>
<td>0.9705</td>
</tr>
<tr>
<td>Left-Eyes vs IOP</td>
<td>(R^2 = 0.0102)</td>
<td>0.9847</td>
</tr>
</tbody>
</table>
CHAPTER V: DISCUSSION

This chapter reports on the key findings related to the research questions of the study. These findings have been correlated with the existing body of knowledge.

5.1 CENTRAL CORNEAL THICKNESS

5.1.1 Mean central corneal thickness and race

The mean CCT for right and left eyes in the patients presenting to the Dr George Mukhari eye clinic was thinner than the documented values for Caucasian participants in various studies (7,8,9,10,14,19,24,29). These values were in keeping with those found in other black participants in international and African studies (7,8,9,10,11,12,18,29,43). However the documented mean for both the right and left eyes was less than that noted in the mentioned studies.

Compared to other South African black participants, the mean CCT values were lower than documented in the KwaZulu Natal study, but higher than documented in the Free State population (13,14).

Most of the above studies used ultrasound pachymetry to measure the CCT (7,8,10,11,13,14,18,29,43). Optical coherence tomography for the measurement of CCT has been found to be comparable to ultrasound pachymetry (33). However, other studies have highlighted the underestimation of CCT by OCT, and suggested the use of a correction factor to account for the underestimation (30,49,50). Since OCT was used to measure pachymetry in this study, the use of this instrument may then be a confounding factor accounting for the reduced mean CCT measurement. The wide range of the central corneal thickness measurements, especially for the right eye (176-604) may have also contributed to the reduced mean CCT value.
5.1.2 Central corneal thickness and age

In this study the mean CCT value for both the right and the left eyes was higher in patients <20 years, compared to those ≥ 20 years. The difference in the mean CCT value between these groups was statistically significant (p= 0.0161 and p=0.0067 for right and left eyes respectively). Importantly, only 3 patients were <20 compared to 298 who were ≥ 20 years. Some studies have found that mean CCT increases with age (15,16), while others have found a decrease with age (10,17,18). However, there are studies that have found no difference in CCT measurements across various age groups (7, 19,43).

5.1.3 Central corneal thickness and gender

Female participants predominated in the study population, which is a trend that has been noted in other studies (10,11,18,19,43). Among the participants, the difference in the mean CCT in males and females was not statistically significant (p=0.4529; p=0.6565 for right and left eyes respectively). Similar findings have been documented by other studies (10,11, 13,14,17,18,19,29,43). Other studies have published a difference in the mean CCT between the genders (7,20,21). These studies have found thicker corneas in male participants. It has been postulated that the difference in CCT between the genders may be due to a hormonal difference (18).

5.2 INTRAOCULAR PRESSURE

5.2.1 Range and mean of intraocular pressure

The measured IOP in the study ranged from 7-46 and 7-50 for right and left eyes respectively. Using the value of 21 as the upper limit of normal, a total of 49 eyes had an increased intraocular pressure prior to any adjustment (26).
The mean IOP prior to adjustment was 15.9 and 16 in the right and left eye respectively. This falls within the normal range (11-21mmHg) for intraocular pressure (26). The difference between the values for the two eyes is not statistically significant. This is similar to findings published by other studies (8,9, 10,11,18).

5.2.2 Intraocular pressure and age

In this study the difference in the mean IOP measured in patients <20 years, compared to those ≥ 20 years was not statistically significant (p=0.8967, p=0.5896 for right and left eyes respectively). This is supported by a study published in 2002, conducted within a Caucasian population (19). However, the age of their study population ranged from 50-85 years.

Other studies have found IOP to vary with age. One such study examined 3,280 Malay participants (51). They found that IOP increased with age up to the sixth decade, and then decreased with age beyond that. However their youngest participants were 40 years old. Another study conducted in a black population group, documented an increase in IOP with age (18). The ages of these participants ranged from 5 to 75 years.

5.3 NEED FOR ADJUSTMENT OF INTRAOCULAR PRESSURE BASED ON CENTRAL CORNEAL THICKNESS

The IOP was adjusted if the cornea was thinned, based on the equation by Ehlers (2). In this study 82.3% and 84% (right and left eyes respectively) needed adjustment of their IOP based on the CCT reading deviating from the reference value of 520 micrometres by more than 10 micrometres. Among those requiring adjustment 30.8% and 26.2% (right and left eyes respectively), the adjustment resulted in a decrease in the IOP. This means that these patients had thicker CCT value, with an overestimation of their IOP. These are patients who may
have been incorrectly labelled as an ocular hypertensive or glaucoma suspect purely on the basis of their IOP reading prior to adjustment (7).

A more significant number of patients, 69.2% and 73.8% (right and left eyes respectively) had an adjustment that resulted in an increase in the IOP. These patients had a thinner CCT value, which resulted in an underestimation of the IOP reading. Some of these patients may have been incorrectly classified as having normal tension glaucoma (7).

Interestingly, prior to adjustment 8.3% and 8% (right and left eyes respectively) had an IOP greater than 21. This is compared with 12.7% and 13.7% (right and left eyes respectively) who fell into this category after adjustment. Therefore, an additional 4.4% and 5.7% (right and left eyes respectively) would have not been included in this category. The difference in the number of patients who had an IOP greater than 21 prior to adjustment (right and left eyes) and after adjustment was statistically significant (p<0.0001). Clinically these additional patients would have benefited because the diagnosis of glaucoma would have been suspected in these patients and they would have been examined and investigated accordingly.

These results can be compared to a study among Cameroonian participants (18). They found that 48% of participants required an adjustment that resulted in an increase in the IOP, while 17% required an adjustment resulting in a decrease in the intraocular pressure. However, they studied a larger number of eyes (970) and used a different reference point for normal CCT thickness (527-560 micrometres).

5.4 CORRELATION BETWEEN CENTRAL CORNEAL THICKNESS AND INTRAOCULAR PRESSURE
Pearson’s Correlation Coefficient demonstrates the linear relationship between two variables. In the study it was used to determine if the measured CCT was related to the measured IOP. This was calculated separately for eyes with a CCT value less than 520 micrometres and 520-600 micrometres. This study found that the measured CCT and the IOP did not correlate with each other in both categories.

Other studies have also found similar results. A study published in 2001 reviewed 73 patients (52). They however measured the intraocular pressure with a different applanation tonometer (Perkins) and also measured the intracameral IOP. They found no correlation between the CCT and both IOP readings. A subsequent study, published in 2006, had a more closely related methodology in their use of Goldmann applanation tonometry (11). Although the black participants in their study also had thinner mean CCT measurements (518 ±31.5), they did not find this to correlate with the measured IOP.

Other studies have found a correlation between the CCT and IOP. A study published in 2003, examined various racial groups within the United States of America (7). They found a positive correlation between the measured CCT and GAT within all of the racial groups. Another study performed in an Ethiopian population group, examined 199 patients (43). They also found a positive correlation between the CCT and GAT. However, all of the examined patients were already diagnosed with glaucoma.
CHAPTER VI: CONCLUSION, LIMITATIONS, AND RECOMMENDATIONS

6.1 CONCLUSION

Several authors have documented the presence of thinner CCT measurements in black population groups. The findings of this study are in agreement with those studies. The mean CCT in this population group is thinner than that documented in Caucasian population groups. It is however, comparable to that documented in other black population groups, especially those within the South African context. Although no correlation was found between the mean CCT value and the IOP, the possibility of a relationship between these two factors cannot be excluded.

The impact of a reduced mean CCT value is seen in the influence that it had on the adjusted GAT reading. In the absence of the adjustment for CCT, a significant number of patients with an elevated IOP would have not been detected. The implication of this is a negative impact on the diagnosis, classification, and management of glaucoma in this population. The prevalence of this condition and the detrimental effect of late detection highlight the importance of any measures that improves the accuracy of the measured IOP. The similarity of the measured CCT value in both genders and in different age groups implies that the impact is applicable throughout the entire population group. Those providing ophthalmic care within our setting cannot ignore this influence if optimal care is to be provided to patients.

6.2 LIMITATIONS

This study had a small sample size; it did not include all of the various racial groups, and was limited to a specific geographic location. In addition it included patients who had been referred to a tertiary institution, not healthy members of
the general population. As a result the findings cannot be generalized to the entire South African population.

Another limitation is that the CCT was obtained using OCT. OCT is not considered the gold standard for pachymetry measurement. It was also not the method used in the majority of sited studies. Lastly, a significant limitation of the study was the use of an IOP estimate obtained using GAT. This was done to reduce the invasive nature and risks of the study. A true IOP reading can only be obtained using specialised equipment to cannulate the eyes in a theatre setting.

6.3 RECOMMENDATIONS

Based on the findings of this study, the researcher recommends the following:

• In our population group the CCT measurement must be documented routinely for each patient. This will aid in improving the accuracy of the GAT readings. In addition, a thinner cornea may have implications for other aspects of the patients’ ophthalmic care.

• The IOP reading must be accompanied by a full ophthalmic exam with appropriate investigations for the proper diagnosis of POAG, ocular hypertension, and NTG. The presence of a normal IOP in isolation, even after adjustment, does not exclude the diagnosis of glaucoma.

• At this facility OCT can be used for CCT measurement in the absence of an ultrasound pachymeter. This method also has the advantage of being less invasive and safer for the patients.

• Further studies in the South African context with larger sample sizes and in different black populations groups must be done. This will help to
increase the knowledge regarding CCT measurements and its impact in other population groups.
REFERENCES


MEDUNSA RESEARCH & ETHICS COMMITTEE

CLEARANCE CERTIFICATE

MEETING: 08/2014

PROJECT NUMBER: MREC/M/303/2014: PG

PROJECT:

Title: The impact of central corneal thickness on intraocular pressure as seen in patients presenting to Dr George Mukhari Academic Hospital

Researcher: Dr T Nthangeni
Supervisor: Dr JB Matlala
Hospital Superintendent: Dr MC Holm
Department: Neurology, Neurosurgery, Ophthalmology and Otorhinolaryngology
School: Medicine
Degree: MMed Ophthalmology

DECISION OF THE COMMITTEE:

MREC approved the project.

DATE: 02 October 2014

DR C BAKER
DEPUTY CHAIRPERSON MREC

The Medunsa Research Ethics Committee (MREC) for Health Research is registered with the US Department of Health and Human Services as an International Organisation (IORG0004319), as an Institutional Review Board (IRB00005122), and functions under a Federal Wide Assurance (FWA00009419)

Expiry date: 11 October 2016

Note:

i) Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee.

ii) The budget for the research will be considered separately from the protocol. PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.
STUDY LEAFLET

Setswana version

Glaucoma ke eng?

Glaucoma ke bolwetse bo bo tlwaelegieng ba matlhho. Bo baka bofufu bo bo sa foleng. Bolwetse bo, ge go tshwere bo baka tshenyego ya mothapo o tlogang mo leitlhong o ya ko bokong.

Ke mang a ka tshwaetswang ke bolwetse ba glaucoma?

- bagolo
- batho bantsho
- ba losika lwa o tshwaeditsweng
- balwetse ba malwetse a farologaneng jaka bolwetse ba sukiri

Kgatello kgotsa phoresha e e ko godimo ya matlhho, ke yona go le gantshi, e golaganngwang le bolwetse bo, ba phoresha e kwa godimo. Re dirisa insiturumente e e bidiwangthonometha (tonometer) go itse gore phoresha e, e bogodimo bo bo kae.

Lebaka la dipatlisiso

Go lemogilwe gore balwetse ba glaucoma mo tliniking ya matlhho ba lemogiwa morago ga sebaka, matlhho a setse a senyegile. Thonometha e re e dirisang e, go cheka diphoresha, ga e diriwa diteko tsa go Cheka gore e dia setsele, e lekilwe mo bathong ba e seng ba morafe o o tlang mo tliniking ya rona. Potso e kgolo ke gore: A e re fa diphoresha tsa nnete kgotsa nnya ka e sa lekiwa mo morafeng wa balwetse ba re ba bonang mo tliniking ya rona? Ka go re jalo, lebaka le legolo la go dira dipatlisioso tse, ke gore re solofela gore re ka nna le kitso ka gore thonometha e, e maleba mo morafeng wa balwetse ba re ba bonang kgotsa nnya. A e npea diphoresha tsa balwetse ba rona. Gongwe lebaka la gore ba tle matlhho a setse a senyegile ke gore thonometha e fosa diphoresha.

Ke dimeshamente di feng tse di tlo tseiwang?

Go dimeshamente tse pedi tse di tillinge go tseiwa. Wa nthla meshamente e tla nna kgatello kana phoresha ya matlhho. Re tla dirisa thonometha go meshara diphoresha. Meshamente wa bobedi e tla nna wa go cheka gore leitlhho mo pele le bokima bo bo kae. Gore botlhoko bo sa utlwagala ge dimeshamente di tseiwa, re tla dirisa ditlhare tsa go tshela mo matlhom tse di fedisang botlhoko.
Data Collection Sheet

Study Number:

Date:

1. Demographic information

   Age

   Race

   Gender (M=1 F=2)

   Current residence (Province):

       (Gauteng=1, Limpopo=2, North West=3, other (specify)=4)

2. Clinical information

   Intraocular pressure (in mmHg): right

   left

   Central corneal thickness (in micrometers):

       Reading  

              right

       left     

3. Adjusted intraocular pressure

   right  

   left
UNIVERSITY OF LIMPOPO (Medunsa Campus) ENGLISH CONSENT FORM

Statement concerning participation in a Clinical Trial/Research Project.

Name of Study:

The impact of central corneal thickness on intraocular pressure as seen in patients presenting to Dr George Mukhari Hospital

I have read the information on */heard the aims and objectives of* the proposed study and was provided the opportunity to ask questions and given adequate time to rethink the issue. The aim and objectives of the study are sufficiently clear to me. I have not been pressurized to participate in any way.

I understand that participation in this Clinical Trial / Study / Project* is completely voluntary and that I may withdraw from it at any time and without supplying reasons. This will have no influence on the regular treatment that holds for my condition neither will it influence the care that I receive from my regular doctor.

I know that this Trial / Study / Project* has been approved by the Medunsa Campus Research and Ethics (MREC), University of Limpopo (Medunsa Campus) / Dr George Mukhari Hospital. I am fully aware that the results of this results of this Trial / Study / Project* will be used for scientific purposes and may be published. I agree to this, provided my privacy is guaranteed.

I hereby give consent to participate in this Trial / Study / Project*.

.......................................................... ..........................................................
Name of patient/volunteer Signature of patient or guardian.

..........................................................
Place.

..........................................................
Date.

..........................................................
Witness

Statement by the Researcher

I provided verbal and/or written* information regarding this Trial / Study / Project*
I agree to answer any future questions concerning the Trial / Study / Project* as best as I am able.
I will adhere to the approved protocol.

..........................................................
Name of Researcher

..........................................................
Signature

..........................................................
Date

..........................................................
Place

*Delete whatever is not applicable.
DECLARATION

I declare that The impact of central corneal thickness on intraocular pressure as seen in patients presenting to Dr George Mukhari Hospital is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other institution.

Dr. Tshilidzi Hulisani Nthangeni                          Date: 9/01/2016.