Central corneal thickness in a healthy Spanish population☆

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ABSTRACT

Objective: To study the central corneal thickness of a Spanish population group and determine the influence of age, gender, axial length and refractive error on central corneal thickness (CCT) values.

Methods: An observational, cross-sectional, double masked study was conducted on 357 eyes of consecutive Caucasian patients without ophthalmic disease. They were distributed according to age, and high refractive defects were excluded. Ultrasonic pachymetry and a complete eye examination were performed on all patients. The relationship between the central corneal thickness values and variables of age, refractive error, axial length and gender was assessed.

Results: The mean central corneal thickness was 548.21 µm with a standard deviation (SD) of 30.7 µm (range 464 to 633 µm). The normal central corneal thickness value of the population studied was 486.81 to 609.61 µm (95% confidence interval). No statistical association was found between central corneal thickness values and variables of age, refractive error, axial length and gender.

Conclusions: Central corneal thickness varies according to race. We have analysed, for the first time, normal central corneal thickness values of a healthy Spanish population.

Espesor corneal central en una población sana española

Objetivo: Estudiar el valor del espesor corneal central (ECC) en población sana española y su relación con la edad, el sexo, la longitud axial y la refracción.

Método: En este estudio observacional transversal enmascarado incluimos pacientes consecutivos de raza caucásica, sin enfermedad ocular conocida. Se seleccionó un total de 357 ojos, repartidos homogéneamente por décadas etarias, excluyendo defectos de refracción altos. Se realizó una paquimetría ultrasónica central de múltiples tomas y una exploración oftalmológica completa por el mismo evaluador. Se analizaron los valores medios...
Introduction

The central corneal thickness (CCT) is a highly interesting parameter in glaucoma, refractive surgery and corneal diseases. As regards the former, this parameter became important when the Ocular Hypertension Treatment Study (OHTS) demonstrated that low CCT is an independent risk factor for the development of glaucoma in patients with ocular hypertension.1 Similarly, it must be taken into account that high CCT values lead to an overestimation of intraocular pressure values (IOP),1 and also that, even in the absence of an algorithm that would adequately ponder this overestimation, the CCT value is a factor in the therapeutic approach in daily clinical practice at the present time. Even so, other viscoelastic characteristics of the cornea are being analyzed as risk factors in glaucoma.

In the planning, refractive procedure, the CCT value is useful for deciding whether a patient should be considered before surgery and which technique would be most adequate.2

In corneal pathology, the CCT value is necessary for diagnosing and following up corneal ectasia such as keratocone, pellucid marginal degeneration or keratoglob.3

On the other hand, several studies have demonstrated the influence of race in ECC,4-10 with very few studies being made in the European population:4,5 Altinok et al.4 carried out a survey in the Turkish population which is not applicable to our population due to racial differences. In addition, Rüfer et al.11 utilized Orbscan II, which is less precise for measuring CCT. We did not find any study on the CCT for the healthy Spanish population.

Considering the above, to decide whether a cornea is thick or thin in order to adopt an adequate diagnostic and therapeutic approach, a CCT study must be carried out amongst our healthy population and should be utilized as a reference in daily practice.

Subjects, material and method

The objective was to study the CCT value in the healthy Spanish population and the relationship of these values with age, sex, axial length and refraction.

A masked, transversal and observational study was designed, including consecutive patients. The patients included in the study were of Caucasian race, without any known ocular disease (normal cornea and visual acuity values), who attended the routine checkup at the Príncipe de Asturias University Hospital (Alcalá de Henares, Madrid, Spain) and voluntarily agreed to participate in the study. All the procedures were adapted to the principles of the Helsinki declaration of biomedical research.

357 eyes were selected, homogeneously distributed in decades of life, excluding high refraction effects (over 6 diopters of myopia, over 5 diopters of emmetropia, over 2 diopters of astigmatism) and eyes with corrected visual acuity below the unit.

One eye of each patient was analyzed, choosing the right eye when both eyes fulfilled the study inclusion criteria.

In all the cases a full ophthalmological exploration was performed by the same specialist: refraction, slit lamp study, biometrics study with axial length and CCT measurements under topical anesthesia. CCT was measured with ultrasonic pachymetry (Ultrasonic Pachymeter Pachette 2 DGH Technology Inc.). Fifteen automatic measurements were taken and the mean thereof was registered.

The mean values for CCT, age, refraction and axial length were analyzed. In addition, the CCT – axial length ratio was analyzed as well as age and refractive defects through linear regressions and Pearson’s correlation coefficient. For analyzing the influence of age in the upper and lower quartiles of our population as well as sex in CCT, the non-paired, two-tail t for Student test was utilized. Finally, the CCT percentage distribution was analyzed.

The statistical analysis was made with the Statview SE+Graphics (Abacus Concepts Inc., Berkeley, CA) software utilizing a Macintosh PowerBook 1400cs/117 computer (Apple Computer Inc., Cupertino, CA, USA).

Results

Overall, 357 eyes were analyzed, 207 of males (58%) and 150 of females (42%). The demographic characteristics of the study population are described in table 1. The normal CCT value in
Our population was of 486.81 to 609.61 µm (confidence interval 95%).

The linear regression analysis and Pearson correlation coefficient for age, axial length and refractive defect with CCT demonstrated the absence of any significant correlation, as can be seen in table 2.

To analyze the influence of the various age groups in CCT, the population was divided in quartiles, selecting the lower quartile (≤ 29 years, CCT=544+/−29.7 µm) and upper quartile (≥50 years, CCT=550+/−31.8µm). The non-paired, double tail t for Student analysis of this data was not significant (p=0.3).

The mean CCT value in males was of 546.2+/−31.8 µm (mean+/−standard deviation), while in females it was of 552+/−29.3µm, without reaching statistical significance (p=0.005).

The CCT distribution in percentages is shown in figure 1.

## Discussion

Racial influence in CCT has been evidenced in various studies. We have not found any study on CCT with healthy Spanish population allowing us to take scientifically-based decisions in our daily clinical practice. In our study we have obtained a mean CCT value of 548.21+/−30.7 µm with a range of 464 to 633µm in the healthy Spanish population.

The obtained CCT values, compared to the population of our environment, is similar to that of the study of the Turkish population (548 vs 552 µm). Similarly, Doughty et al.5 carried out a meta-analysis for obtaining the mean CCT on the basis of publications between 1968 and 1999. obtaining a mean CCT value in Caucasian population of 535 μm, which is slightly lower than the figure of our population.

Comparing the mean CCT with other races throughout the world, we found that it is higher than the values obtained in two Australian aborigine populations (514 and 511 µm)7,8 and 1 population of northern Africa6 (548 vs 519 µm). It was also similar to the values obtained for the Caucasian population in two studies (544 and 541 µm).7,8 However, there seemed to be intra-racial differences as the CCT obtained in an adult Chinese population was of 551 µm9 whereas in the Chinese population of Hong Kong it was 575 µm.10

In our study we have not found a statistically significant association between CCT and age, sex, axial length or refraction.

In our analysis of the relationship between age and CCT we did not find a statistically significant association, in contrast with the findings of other studies.4,9,10,12,13 Figure 1 displays a certain correlation between CCT and age, but it is so slight that these differences would be significant only with a high number of patients. At the clinical level funds, these small differences lack importance.

The Association between CCT and sex has been analyzed in various studies in most of which, as in ours, statistically significant differences were not found.6,12,13,14,15 In contrast, some studies have found a statistical association between both factors,4,9,16 even though the data obtained are contradictory, and in some cases there seems to be a certain degree of confusion when sex and age are analyzed jointly. In any case, there are studies about the modifications of corneal thickness in women under the influence of sexual hormones during their menstrual cycle,17-19 a factor to be analyzed in greater depth in subsequent studies.

As with our own study, the majority of published studies that analyzed the relationship between axial length and CCT did not find statistical association.14,20,21,22. Only the Singapore Malay Study23 found a relationship between these 2 factors. New studies are required to confirm this finding.

Most of the studies6,9,10,13,20,24 did not find a relationship between refraction and CCT, as was the case in our population. This matches the absence of any relationship between CCT and axial length.

Some of the strengths of our study includes that this is the first one of the kind carried out in our country that provides

### Table 1 – Demographic characteristics of the study sample.

<table>
<thead>
<tr>
<th></th>
<th>Mean+/−standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>39.2+/−13 years; Range: 15 to 76 years</td>
</tr>
<tr>
<td>Sphere</td>
<td>−2.12+/−3 dioptres</td>
</tr>
<tr>
<td>Cylinder</td>
<td>−0.67+/−1.4 dioptres</td>
</tr>
<tr>
<td>Central corneal thickness</td>
<td>548.21+/−30.7 µm; Range: 464 to 609.61 µm</td>
</tr>
<tr>
<td>Axial length</td>
<td>24.26+/−1.6 mm</td>
</tr>
</tbody>
</table>

### Table 2 – Linear regression and Pearson correlation coefficient analysis for age, axial length and refractive defect with CCT.

<table>
<thead>
<tr>
<th></th>
<th>p</th>
<th>R</th>
<th>r²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.3</td>
<td>0.05</td>
<td>0.003</td>
</tr>
<tr>
<td>Axial length</td>
<td>0.2</td>
<td>0.05</td>
<td>0.003</td>
</tr>
<tr>
<td>Refractive defect</td>
<td>0.4</td>
<td>0.04</td>
<td>0.002</td>
</tr>
</tbody>
</table>

A p<0.05 value was considered to be significant.

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Figure 1 – Central corneal thickness (CCT) distribution in an age percentage distribution.
a normal value for CCT (486.81 to 609.61 µm; confidence interval of 95%), in a homogeneously distributed population in decades of age groups without extreme refractive defects and normally ophtalmological exploration.

Even though it is a study with a moderate sample as it is not based on population but on patients who requested the ophtalmological attention in our hospital, it is possible that the prevalence of refractive defect may be higher. This effect does not play a large role in the validity of the study because extreme defects have been excluded and, as described in the discussion, refraction does not influence CCT values.

In conclusion, the normal CCT value in the Spanish population was of 548.21+/−30.7 µm with a range of 464 to 633 µm. in our study we did not find a statistical association between CCT and age, sex axial length of refractive defect.

**Conflict of interests**

None of the authors have declared any conflict of interests.

**References**

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