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Central corneal thickness and degree of myopia in the adult myopic population of Almería, Spain

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SUMMARY

The aim of this work is to determine the values and study the relationship of central corneal thickness (CCT) and the degree of myopia (DM) in the adult myopic population aged 20-40 years in Almería, Southeast Spain. To our knowledge this first study addressing these issues in this region.

A cross-sectional, descriptive, observational study in which 310 myopic patients aged 20-40 years were selected by sex- and age-stratified sampling which was proportionally fixed to the population strata size, for which 20% prevalence of myopia, 5% epsilon and 95% confidence interval were hypothesised. CCT and DM and their relationships were studied by calculating means, the standard deviation, the 95% confidence interval for means, the median, Fisher's (asymmetry) coefficient, range, maximum and minimum and Brown-Forsythe's robust test for each variable. CCT measurements were taken with a DGH 4000 B ultrasound pachymeter, and subjective and objective ocular refractions were performed with a Nidek AR-6000 auto-refractor.

In the adult myopic population of Almería aged 20-40 years (mean age, 29.8), the mean overall CCT was 550.12 micrometers. In general, no statistical differences were found between the right (548.98) and left (551.19) eyes (p=0.426). The CCT was thicker for men (553.62) than for women (546.61) (p=0.014), and there were no significant differences (p=0.553) in CCT for the 20-40 age group; therefore CCT is stable with age. The overall DM was -4.18 dioptres, with no statistically significant differences between the right (4.17) and left (4.19) eyes (p=0.901) in general. Men had less myopia (media -3.82) than women (mean -4.54) (p<0.001). Myopia was stable in the 20-40 age group (p=0.089). We found no linear relationship between CCT and DM.

Key words: Central corneal thickness - Myopia - Population-based study - Glaucoma.

INTRODUCTION

Myopia is one of the most frequent refractive defects in the general population. Its prevalence ranges from 17 to 95 and varies according to age, sex and race (Grosvenor and Flom, 1990a, b; Kempen et al., 2004). Knowing the degree of myopia (DM) is interesting to assess the current status of the myopic population and to provide evidence of the growing or diminishing future trends of

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this refractive state in both the number of patients and the degree to which they are affected. All this could be interesting for studies addressing nutrition and lifestyle habits to determine, for instance, the relationship between the number of reading hours, growth and the onset of new myopia cases, and their influence on the DM.

To date, no study has been conducted in our population to determine central corneal thickness (CCT) and DM parameters and their relationships, although similar studies have been carried out elsewhere (Grosvenor and Flom, 1990a, b; Fam et al., 2006; Dueker et al., 2007; Sanchez-Tocino et al., 2007).

It is currently very important to know these parameters and their relationships since knowledge of whether DM is a risk factor for intraocular pressure could influence decision-making in the field of glaucoma treatment (Grosvenor and Flom, 1990a, b; AGIS investigators 2001; Singh et al., 2001; Eysteinsson et al., 2002; Kass et al., 2002; Nemesure et al., 2003; Shimmyo et al., 2003).

These parameters are also very important in the field of refractive surgery because CCT and DM may indicate whether a specific surgical PRK, Lasik or intraocular lens technique should be applied or not (Sharma et al., 2005; Binder et al., 2007).

In the future, knowledge of the influence of drugs (Hanh et al., 2003; Martinez de la Casa et al., 2006; Detorakis et al., 2010) on the degree of corneal moisturisation and, therefore, on CCT and its biomechanical characteristics, may also affect the choice of the pharmacological products that are most suitable for each patient.

Material and Methods

A cross-sectional, descriptive and observational study was designed in which a sample was selected by sex- and age-stratified sampling, which was proportionally fixed to the population strata size. Each stratum was formed by patients of the same sex in one 5-year interval. We did sampling size calculations in finite populations. Given that Almería has a population of 229,460 and since we had previously hypothesised a 20% prevalence of myopia, although we are aware that this prevalence varies in different populations and different ethnic groups, with a 5% epsilon and a 95% confidence interval (CI), a simple random sampling would need a minimum of 244 people. By assuming a design effect of 1.27, the final stratified sample size obtained was 310 patients. The table below presents the sample size per stratum (Table 1).

Table 1. Sample Size per stratum.

Age	20 to 24	25 to 29	30 to 34	35 to 40
Men	31	48	38	38
Women	38	45	34	38

Inclusion criteria: patients aged between 20 and 40 years with any degree of myopia and with a degree of astigmatism lower than 1 dioptre and who had no ocular diseases.

Exclusion criteria: emmetropia, hypermetropia or/and astigmatism with more than one dioptre.

A visual acuity test (VA) was performed with a standard optotypes projector, ocular refraction was carried out with a Nidek AR-6000 auto refractor, and ocular topography was done with an Allegro Oculyzer. The horizontal, vertical and mid corneal curvatures, as well as the asphericity factor, were measured. Intraocular pressure was measured with a Canon TX-10 tonomoter. A Topcon slit-lamp was used for the ophthalmoscopic examination; a DGH 4000 B pachymeter was employed for pachymetry purposes, and the back of the eye was examined by direct ophthalmoscopy.

Statistical analyses

We calculated the mean, standard deviation, 95% confidence interval for the mean, the median, Fisher's (asymmetry) coefficients, range, maximum and minimum for each variable, the overall sample and each stratum. To verify possible sex differences, we used Student's t-test for independent samples in the total sample and in each age group. The possible differences between age groups were calculated with the Brown-Forsythe robust test (for the myopia and CCT variables) for the overall sample and by stratifying the results by sex. We considered Dunnett's post hoc test for the Brown-Forsythe test. We used the Brown-Forsythe test as(since/because?) Levene's test (homogeneity of variances) was significant. Theifferences between the left and right eyes in all the variables were calculated with Student's t-test for related samples; likewise, they were calculated for the overall sample and per stratum. The possible relationships among the variables were verified by linear regression. For

all the statistical analyses, a value lower than 0.05 was considered statistically significant.

Results

Our sample included 310 myopic patients (620 eyes) who were representative of the myopic population of our city (Almería, Southern Spain). This sample was made up of 155 men and 155 women aged between 20 and 40 years (the overall mean age was 29.86, with a standard deviation of 5.55 and a median of 29), of which 69 belonged to the 20-24 age group (31 men and 38 women); 93 were in the 25-29 age group (48 men and 45 women); 72 were in the 30-34 age group (38 men and 34 women), and 76 were aged 35-40 (38 men and 38 women).

1. The overall mean central corneal thickness (CCT) in myopic patients in Almería aged between 20 and 40 years was 550.12, with a standard deviation of 35.56; a 95% CI of (547.31, 552.92) and a range of 200 (minimum value, 440; maximum value, 640); an asymmetry coefficient of –0.06, and a median of 549 (Fig. 1).

The overall mean in the right eyes was 548.98, with a standard deviation of 35.62, a 95% CI of (545, 552.96), a range of 190 (minimum value, 440 and maximum value, 630), an asymmetry coefficient of –0.13, and a median of 549.5. The overall mean in the left eyes was 551.21, with a standard deviation of 35.52, a 95% CI of (547.29, 555.22), a range of 184 (minimum value, 456 and maximum value, 640), an asymmetry coefficient of 0.01, and a median of 549. This difference in the means obtained for the right and left eyes was not statistically significant (p=0.426) and it cannot be extrapolated that the left eyes of our myopic population were thicker (Fig. 2).

The overall mean for men (n=310) was 553.62 with a standard deviation of 35.40, a 95% CI of (549.67, 557.58), a range of 184 (minimum value, 440 and maximum value, 624), an asymmetry coefficient of -0.33, and a median of 550. The overall mean for women (n=310) was 546.61 with a standard deviation of 35.26, a 95% CI of (542.65, 550.57), a range of 180 (minimum value, 460 and maximum value, 640), an asymmetry coefficient of 0.21, and a median of 546.5. The difference between the means obtained for men and women was statistically significant (p=0.014). Therefore, the corneas of our male subjects can be said to be somewhat thicker (Fig. 3).

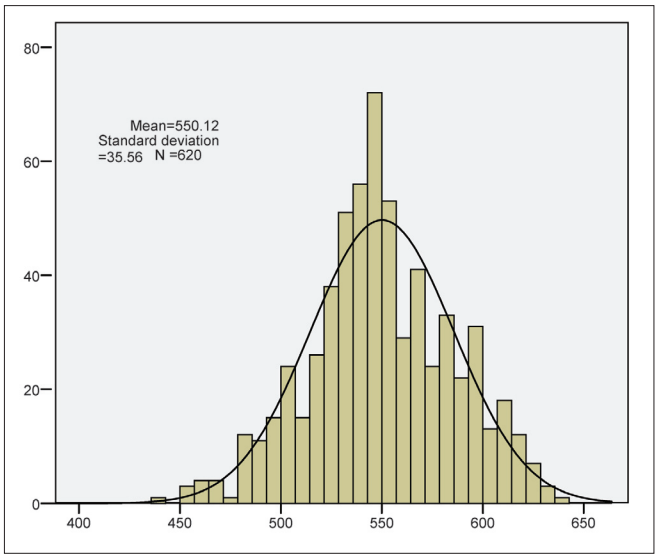

Fig. 1. Distribution of central corneal thickness in the sample.

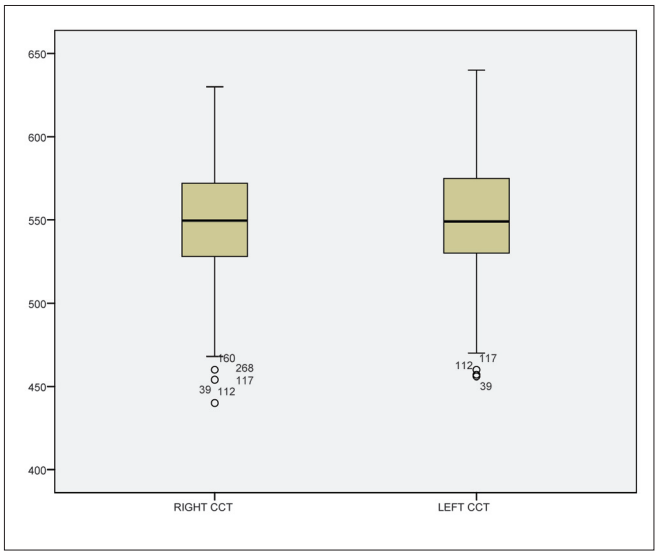

Fig. 2. Comparison of central corneal thickness values between right and left eyes in the sample.

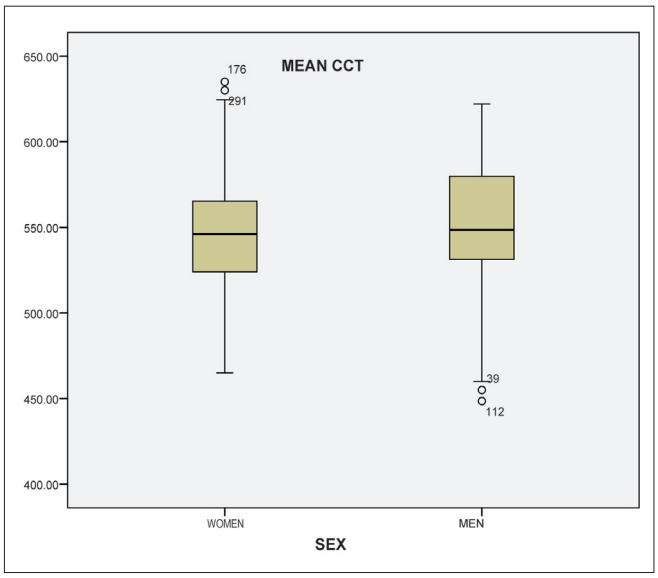

Fig. 3. Comparison of central corneal thickness values between women and men in the sample.

The overall mean obtained for men (n=310) was 553.62, the mean for the right eyes for men was 552.52 with a standard deviation of 35.63, a 95% CI of (546.86, 558.17), a range of 180 (minimum value, 440 and maximum value, 620), an asymmetry coefficient of -0.36, and a median of 551. The mean of the left eyes for men was 554.73 with a standard deviation of 35.25, a 95% CI of (549.14, 560.32), a range of 168 (minimum value, 456 and maximum value of 624), an asymmetry coefficient of -0.30, and a median of 550. The difference in the means obtained between the left and right eyes for men was not statistically significant (p=0.583). The overall mean obtained for women (n=310) was 546.61. The mean of the right eyes for women was 545.44, with a standard deviation of 35.38, a 95% CI of (539.83, 551.05), a range of 170 (minimum value, 460 and maximum value of 630), an asymmetry coefficient of 0.10, and a median of 548. The mean of the left eyes for women was 547.78, with a standard deviation of 35.56 and a 95% CI of (542.14, 553.42), a range of 170 (minimum value, 470 and maximum value of 640), an asymmetry coefficient of 0.31 and a median of 546. The difference in the means between the left and right eyes for women was not statistically significant (p=0.561).

We made an overall comparison and found that the left eyes (553.05) were somewhat thicker than the right eyes (547.22) for both men and women, although the difference was not statistically significant.

On comparing the mean CCT of the right eyes of men (552.52) with the mean CCT of the right eyes of women (545.44), the differences obtained were close to being statistically significant (p=0.08). On comparing the left eyes of both men (554.73) and women (547.78), the values obtained also came close to being significant (p=0.085). Therefore, it may be inferred that, in general, the eyes of the men were somewhat thicker than those of women.

As regards age groups, the CCT values were stable for all age groups (p=0.553). However, it is not possible rule out the null hypothesis of equality of the mean CCT values in all age groups (Fig. 4).

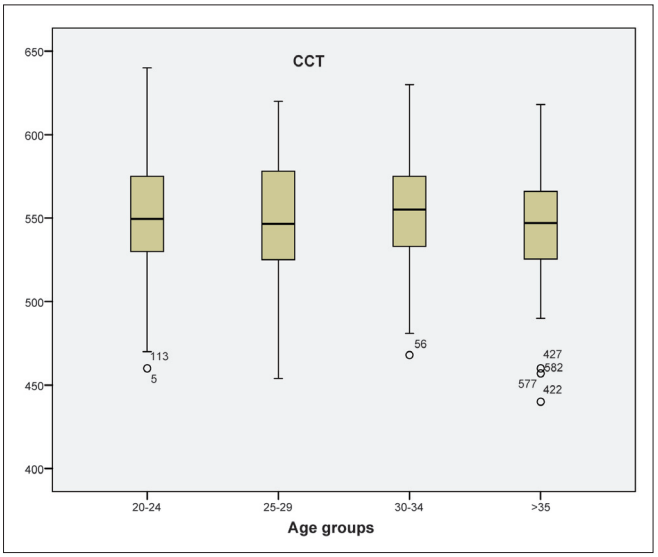

Fig. 4. Comparison of central corneal thickness values among age groups.

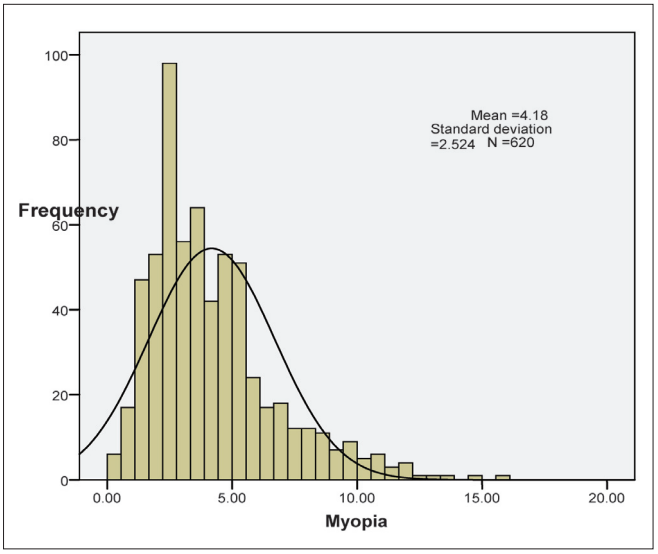

Fig. 5. Distribution of myopia in the sample.

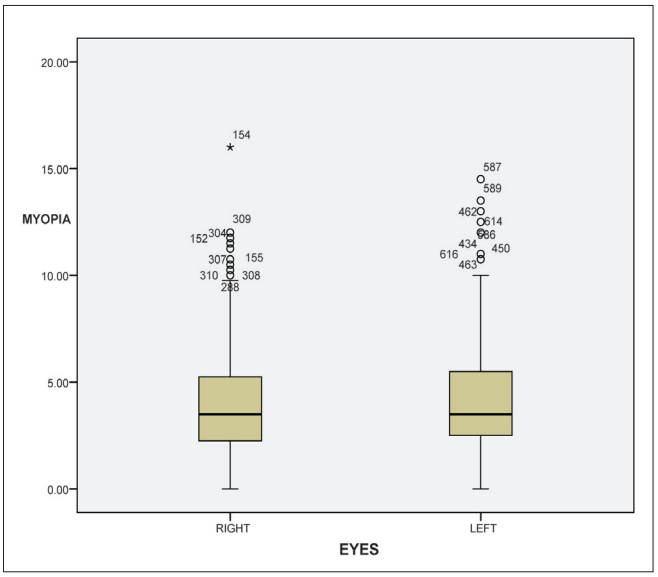

Fig. 6. Comparison of myopia values between right and left eyes in the sample.

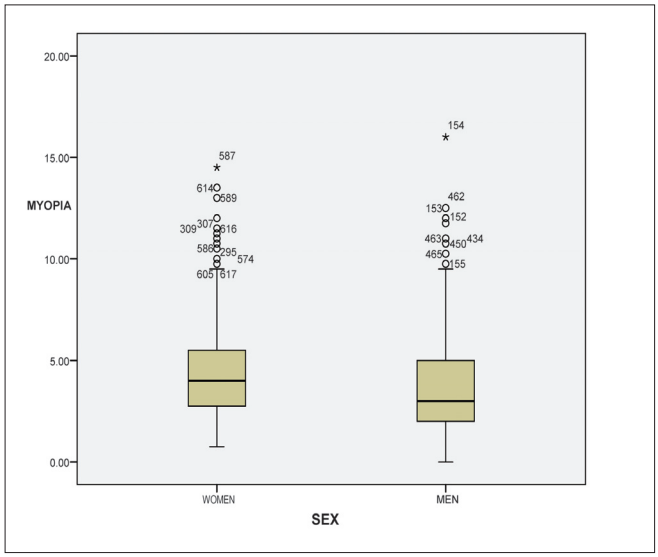

Fig. 7. Comparison of myopia values between women and men in the sample.

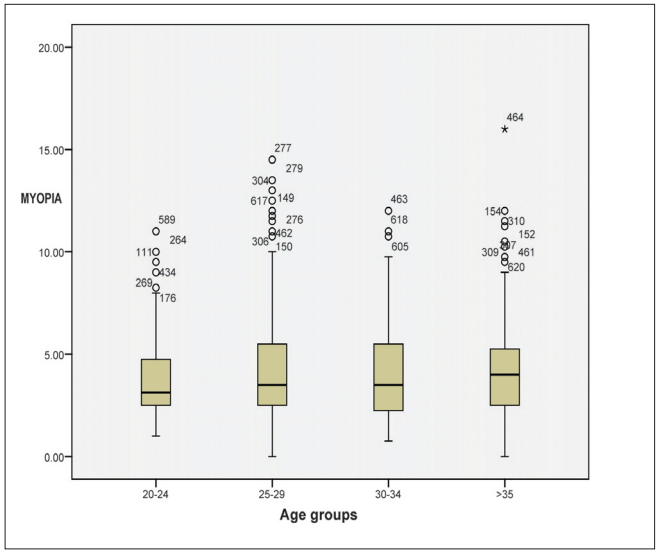

Fig. 8. Comparison of myopia values among age groups.

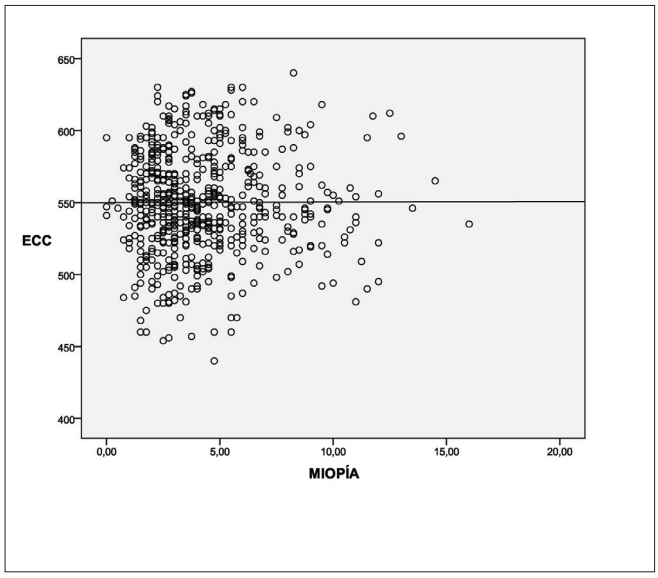

Fig. 9. Scatterplot showing how much ECC is affected by myopia in the sample.

The mean degree of overall mean myopia among our patients in Almería aged 20-40 years was 4.18 dioptres with a standard deviation of 2.52, a 95% CI of (3.98, 4.38), a range of 15 (minimum value of 1, maximum value of 16), an asymmetry coefficient of 1.29 and a median of 3.50 (Fig. 5).

The overall mean for the right eyes was 4.17, with a standard deviation of 2.51, a 95% CI of (3.89, 4.45), a range of 15 (minimum value, 1 and maximum value of 16), an asymmetry coefficient of 1.29, and a median of 3.50. The overall mean of the left eyes was 4.19 with a standard deviation of 2.54, a 95% CI of (3.91, 4.48), a range of 13.50 (minimum value, 1 and maximum value, 14.50), an asymmetry coefficient of 1.29, and a median of 3.5. When these results were compared, we found no statistical significance (p=0.759). However, the null hypothesis of equality of the means between the left and the right eyes cannot be ruled out (Fig. 6).

The mean for men (n=310) was 3.82, with a standard deviation of 2.41, a 95% CI of (3.55, 4.09), a range of 15 (minimum value, 1 and maximum value, 16), an asymmetry coefficient of 1.46, and a median of 3. The mean for women (n=310) was 4.54, with a standard deviation of 2.59, a 95% CI of (4.25,4.83), a range of 13.50 (minimum value, 1 and maximum value, 14.5), an asymmetry coefficient of 1.17, and a median of 4. We found statistically significant differences (p<0.001) and it may be concluded that the women of our study sample had more myopia than the men (Fig. 7).

The mean of the right eyes for men was 3.83,with a standard deviation of 2.45, a 95% CI of (3.44, 4.22), a range of 15 (minimum value, 1 and maximum value, 16), an asymmetry coefficient of 1.67, and a median of 3. The mean of the left eyes for men was 3.81, with a standard deviation of 2.38, a 95% CI of (3.43, 4.18), a range of 11.5 (minimum value, 1 and maximum value of 12.5), an asymmetry coefficient of 1.23, and a median of 3.25. This difference in the means for the left and right eyes in men was not statistically significant (p=0.817), and it may be deduced that the myopia among the men of our study was equal in both eyes. The mean of the right eyes for men was 4.50, with a standard deviation of 2.53, a 95% CI of (4.10, 4.91), a range of 11 (minimum value, 1 and maximum value, 12), an asymmetry coefficient of 1, and a median of 4. The mean of the left eyes for women was 4.58, with a standard deviation of 2.65, a 95%

CI of (4.16, 5.00), a range of 13.50 (minimum value, 1 and a maximum value, 14.50), an asymmetry coefficient of 1.32, and a median of 4. The difference in the means obtained was not statistically significant (p=0.532), and it may be deduced that the eyes of the women of our study sample were equal.

As regards age groups, myopia was seen to be stable (p=0.089) (Fig. 8).

We found no linear correlation between CCT and the degree of myopia (DM). (Sqr=0,p=0.956) (Fig. 9).

Discussion

We centred this study on a healthy myopic population aged 20-40 years because we believe that the period between these ages is one of refractive stability (Grosvenor and Flom, 1990a, b; Shimmyo et al., 2003). Accordingly, the mean values for corneas can be considered to be stable since they are not affected by growth or ageing. It was easy to cover this population given the number of patients who come to our consultations.

In this study, we found a mean corneal thickness of 550.12 μm, which is similar to that obtained in other studies; for instance, the mean of 544.34 obtained in Spain by Sánchez-Tocino et al. (2007), that of 543.8 in Saudi Arabia (Al-Mezaine et al., 2009), and the mean of 546.9 found in Latin-American individuals by Hahn et al. (2003) which is lower than that obtained by La Rosa et al. (2001) in a Caucasian American population. The results do not completely coincide because the studies were not based on the same population group (healthy myopic individuals aged 20-40 years). In the study of Almezaine et al. (2009), emmetropia groups were differentiated from myopic groups, while the study of Sánchez-Tocino covered all types of patients and ages. Thus, a comparison with these two studies would not be completely reliable. It should also be considered that using different pachymeters may also influence the final result obtained (Foster et al., 1998; Nissen et al., 1991; Eysteinsson et al., 2002; Lekskul et al., 2005; Sanchez-Tocino et al., 2005; Tonnu et al., 2005; Martinez de la Casa et al., 2006; Erickson et al., 2009).

We failed to find significant differences in this age group, unlike other authors (Sanchez Tocino et al., 2007; La Rosa et al., 2001; Hanh et al., 2003; Cho et al., 1997; Lekskul et al., 2005) who stated that age is a factor that leads to lower CCT. However, other works did not find this relationship: Nemesure et al. (2003), Shimmyo et al. (2003), and the studies done in Reykjavik (Eysteinsson et al., 2002) and Rotterdam (Wolfs et al., 1997). Since our patients were not aged under 20 or over 40, we have no data available to acknowledge that age is indeed an influential factor. However, we believe that CCT values are affected by age and also by intraocular pressure (IOP), and we firmly believe that glaucoma affects CCT (under study). Thus, it is necessary to adjust the IOP in relation to corneal thickness in order to know each patient's real pressure (Copt et al., 1999; Bron et al., 1999).

Nemesure et al. (2003) encountered a relationship between CCT and age, the refractive state, and having a background of diabetes. In this work, we found no relationship of CCT with the refractive state, which coincides with the results obtained by Sánchez-Tocino, Almezaine and others (Sanchez-Tocino et al., 2007; Al-Mezaine et al., 2009; Cho et al., 1997; Srivannaboon et al., 2002) because the DM did not influence corneal thickness. The differences found by us in terms of sex and laterality coincide with the findings of Alsbirk et al. (1978).

We are well aware that the results of our study cannot be extrapolated to the general population of Almería because it was conducted with myopic subjects only. Evidently, it is necessary to conduct studies among myopic individuals with emmetropic, hyperopic and astigmatic subjects. Having concluded all these studies, we will have obtained an overall view of the values of these parameters among the general population of our city. These parameters cannot be applied to all age groups because we only studied ages between 20 and 40 years since we believe that subjects of these ages show a certain degree of stability since they have finished the growing process but have not commenced the ageing process. Finding the values of the parameters used in this study for other age groups could be addressed in future works. We stress the work of Al-Mezaine et al. (2009), who found a DM of -3.7 in a healthy myopic population and that of Srivannaboon et al. (2002) with a DM of -4.9, which is very similar to that found by us (-4.1). Likewise, those authors also coincide with the results of the present work in the sense that there is a significant difference

between men and women, but not between the left and right eyes.

We are also aware that glaucoma and CCT did not correlate; this is because we did not conduct this study with a group of patients with glaucoma; nonetheless, conducting studies among healthy myopic populations may prove very important.

The importance of CCT lies in the fact that it is essential for establishing therapeutic guidelines for glaucoma (Singh et al., 2001; Sharma et al., 2005; Al-Mezaine et al., 2009) and is a determining factor to establish a patient's true IOP (Singh et al 2001; Dueker et al., 2007). Since it is well-known that there are drugs responsible for modifying CCT values (Wolfs et al., 1997; Brandt et al., 2004; Oliveira et al., 2006; Detorakis et al., 2010) and that these alterations may prove determinant factors upon applying specific therapies, e.g., latanoprost (Detorakis et al., 2010), possible changes in thickness may contraindicate the use of certain drugs for patients having undergone refractive surgery.

Finally, the methods described here are those usually employed in our clinical practice, and we believe they are universally accepted and beyond debate.

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