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Correlation Between Anterior Corneal Curvature Power And Axial Ocular Dimentions In Emmetropic Eyes of Femal Children In Gaza Strip.

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Abstract

Purpose: To investigate the correlation between anterior corneal curvature power (CP) and axial ocular dimensions in emmetropic eyes of healthy children in Gaza. **Methods:** Ninety six emmetropic eyes of healthy female children aged 13 to 15 years (mean = 14 ± 1.00 years) were recruited for this cross sectional observational study. Variables studied were anterior corneal curvature power (CP), central corneal thickness (CCT), axial length (AL),anterior chamber depth (ACD), and lens thickness (LT). **Results:** The average values of CP, CCT, AL, ACD and LT were (43.41 ± 1.49 D), (543.58 ± 36.77 µm), (22.76 ± 0.78 mm), (3.36 ± 0.27 mm) and (3.54 ± 0.18 mm) respectively. There was a significant negative correlation between CP and AL (r=-0.687, p< 0.05). However, none of the other variables studied showed any significant correlation with CP (all p-value > 0.05). **Conclusion:** A population profile of axial ocular parameters was established in Palestinian female children (aged 13-15 years) for the first time. There was negative correlation between CP and AL, while CP was not correlated with CCT, ACD or LT. Our study suggests that CP decreases with axial elongation. Findings of this study can be used as a reference for diagnostic and clinical purposes.

Keywords:
Anterior chamber depth, Anterior corneal curvature power, Axial length, Central corneal thickness, Lens thickness.

1. Introduction:

The refractive state of the eye is determined by its refractive components which include the anterior corneal curvature power (CP), lens power, axial length (AL) and anterior chamber depth (ACD). These parameters are considered to be interdependent rather than independent variables. In fact, the human eye develops during the early years of life in a properly estimated manner in which the refractive state of the eye tends towards emmetropia(Hirsch & Weymouth, 1947). The development of the refractive state of human eye depends on the balance of alteration in axial length and refractive components, particularly the alterations in the cornea and the crystalline lens(Troilo, 1992). It's well established that the majority of eye growth occurs in the first eighteen months of life after which only minor variations take place(Flitcroft, Knight-Nanan, Bowell, Lanigan, & O'Keefe, 1999). In general, the changes in AL appear to be more important than the progressive corneal flattening that occurs with age in normal eyes[4]. The majority of axial elongation takes place in the first three to six months of life and is followed by a slow and regular reduction of growth over the next two years(Grosvenor & Scott, 1994), and by three years of age the adult eye size is properly attained(Atchison, 2017). The cornea is the most powerful refracting surface of the optical system of the eye which accounts for two thirds of the optical refracting power of the eye. In addition, CP and AL are essential for the accurate determination of the intra-ocular lens (IOL) before cataract surgery(Mashige, 2013). In addition, anterior corneal curvature power, in particular, is used in contact lens fitting(Tien Yin Wong et al., 2001). Abnormal values of the anterior corneal curvature radius(Eysteinsson et al., 2002)(Wu et al., 2007)(Lim et al., 2010)(Vurgese et al., 2011)(Grosvenor & Scott, 1994), such as in keratoconus or cornea plana, or great variation in axial length, such as in axial myopia or hyperopia, lead to severe refractive ametropias. On the other hand, researchers have studied the interaction between AL and anterior corneal curvature power and its effect on the compensatory adjustments of the optical components of the eye towards attaining an emmetropic state(Cole, 1982). The aim of this study is to evaluate the relationship between anterior corneal curvature power and axial ocular dimensions in emmetropic eyes .

To the best of our knowledge, this research is the first study performed in Gaza strip, Palestine.

SUBJECTS AND METHODS:

A total of 96 female subjects aged 13–15 years were recruited from different schools in Gaza strip and examined at the optometry department of the Islamic University of Gaza (IUG). All subjects were given a consent form to be signed by their parents or legal guardian. All procedures involved in this study adhered to the Declaration of Helsinki for research involving human subjects. The following exclusion criteria were used: IOP > 21 mmHg; previous history of contact lens wear; connective tissue disorders; previous history of surgery or ocular trauma, uncorrected visual acuity < 6/6 in either eye, refractive errors outside the limits of (-0.25Ds to +1.00Ds and -0.25Dc to -0.75Dc). Ophthalmic examination included slit lamp examination, IOP measurement, refraction, CP, CCT, ACD and AL measurement. IOP was measured using Goldmann applanation tonometer. Refraction was done as follows : all enrolled subjects underwent the measurement of distance uncorrected visual acuity using Snellen E-chart (Good-lite Co., Elgin, IL,USA), and only those who attain 6/6 vision in each eye were included in the study. Non-cycloplegic refraction was then measured with an auto-keratorefractometer (Topcon KR-8800; Topcon Corp.).The average of four reliable readings was considered as the valid reading. Finally, all students underwent subjective refraction. To minimize the impact of refractive status on study parameters, the study included only emmetropic eyes of healthy students. Emmetropia here was defined as those with refractive status between (-0.25Ds to +1.00Ds and -0.25Dc to -0.75Dc) by auto-keratorefractometer, and attained 6/6 vision in each eye without any optical correction. CP was determined with an auto-keratorefractometer (Topcon KR-8800; Topcon Corp.). The instrument was calibrated by using a stainless steel ball bearing of 44.75 D curvature. Measurements were made along the two major meridians and the mean of four readings for each meridian was recorded. The average of both values of the major meridians represented the mean CP. Central corneal thickness , ACD, LT and AL measurements were obtained using ultrasonography (PacScan Plus ,300AP+ Sonomed Inc., Lake Success, NY, USA). The mean of 5 readings for each parameter was used for analysis. All optical measurements were performed by two experienced optometrists. Axial ocular dimensions were measured by one optometrist, and CP was obtained by the another optometrist. Data analysis was conducted with IBM SPSS (Version 20.0, SPSS Inc, Chicago, Illinois, USA). In this study, univariate analyses were used to evaluate associations between CP and each of the dependent variables. The dependent variables were AL, ACD, LT and CCT.

Spearman's correlation test was used to examine associations between the CP and each of the dependent variables.

RESULTS:

Ninety six emmetropic female subjects aged between 13 and 15 years were enrolled in this study. Their mean anterior CP, CCT, AL, ACD and LT measurements were 43.41 ± 1.49 D, 543.58 ± 36.77 µm, 22.76 ± 0.78 mm, 3.36 ± 0.27 mm, 3.54 ± 0.18 µm, respectively. Of significance, among the multiple dependent variables investigated in this study (axial length, anterior chamber depth, lens thickness and central corneal thickness), only one significant negative correlation between CP and AL was found ($r = -0.687$, $p < 0.05$) (Figure 1). None of the other variables showed any significant association with CP ($p > 0.05$) (Figure 2, 3 and 4). Table 1 provides a summary of the average (and standard deviation) measurements of CP, CCT, AL, ACD and LT .

DISSCUSION:

In the present study, CCT, AL, ACD and LT were measured in emmetropic eyes of healthy Palestinian girls to establish their distribution and their correlations with CP. This information has never been reported previously in this population, and is essential to enable appropriate eye care services to be provided. These parameters and their correlations are also important in monitoring ocular aberration analysis, cataract, refractive surgery and congenital glaucoma as well as to diagnose and treat related corneal diseases(Gharaee et al., 2014)(Zha, Feng, Han, & Cai, 2013)(Hashemi et al., 2015)(Venkataraman, Mardi, & Pillai, 2010)(Martin, Ortiz, & Rio-Cristobal, 2013)(Villegas, Alcón, & Artal, 2014)(Muslubas, Oral, Cabi, & Caliskan, 2014).

Distribution of corneal power

The CP in our study (43.41 ± 1.49 D) is close to those obtained by Iyamu and Eze(Iyamu & Eze, 2011) who reported a mean CP value of 7. 85 ±0. 35 mm(43.00 D) in 95 Nigerian individuals aged 20 to 69 years using a manual keratometer. Similarly, Mashige and Oduntan(Mashige, 2013) reported a mean CP value of 7. 88 ± 0. 29 mm, which is almost 42.87 D, in 601 South African individuals aged 10 to 66 years using Oculus Keratograph 4. Another study with close inclusion criterion to ours has been carried out in East China(Zhang et al., 2015). However, this study was a school-based cross-sectional study with a large sample size and investigated the distribution of CP values in children and reported a value of 7.84 ± 0.27 mm in the right eye, which is almost 43.00 D, from 5913 participants aged 4 to 18 years using auto-refractometer. Although CP values of these studies were very similar, general overall comparisons are difficult to make due to different aspects of the study such as sample size, ethnic and racial composition of the children, age groups, gender, measurement techniques, and instruments used.

Correlation between corneal power and axial length

The current study showed that there was a significant negative correlation between corneal power and axial length. Which suggests that CP decreases with axial elongation. This data support the finding of Hoffmann and Hutz(Hoffmann & Hütz, 2010) who showed that the correlation between AL and CP decreased significantly with longer eyes. Guggenheim et al(Guggenheim et al., 2013) and Scheiman et al(Scheiman et al., 2016) also reported that CP and AL were correlated in their studies ($r = 0.54$ and $r = 0.57$, respectively). Guggenheim et al(Guggenheim et al., 2013) suggested that specific genetic variants , environmental factors may all play a role in changing the coordinated growth of these components in ametropic eyes. In contrast to our results, a South-African study(Mashige, 2013) found that there was a significant positive but mild correlation (r =0. 40 , P=0.00) between CP and AL in a mixed population of children and adult aged 10 to 66 years. This study suggested that on average, longer eyes have flatter corneas. The difference in these results, including the current study, is most likely related to intrinsic and extrinsic factors such as : the ethnic and racial composition of study samples, age, gender, instruments, genetics and hereditability, and environment, etc.

Correlation between corneal power and other variables (CCT, ACD and LT)

In this study we found that there was no significant correlation between corneal power and CCT. Suzuki et al[28] and Tong et al's(Tong, Saw, Siak, Gazzard, & Tan, 2004) showed that there was a positive correlation between CCT and corneal power (P < 0.05). Our results are in contrast with those of Shimmyo et al(Shimmyo, Ross, Moy, & Mostafavi, 2003) Tajimi study(Sawada, Tomidokoro, Araie, Iwase, & Yamamoto, 2008) who reported that CCT was positively correlated with corneal power in a relatively large sample size. Different methodologies, inclusion criteria, age , gender, race and ethnicity, instruments, and measurement techniques could explain the variations in previous investigations. No correlation between CP and ACD was found in this study, which is in agreement with a study reported by Carney et al(Carney, Mainstone, & Henderson, 1997)(Chang, Tsai, Hu, Lin, & Shih, 2001)(Goss, Van Veen, Rainey, & Feng, 1997). The authors also found that eyes with flatter corneas had higher LT values, which was not observed in our study (r=-0.03, P=0.88). It has been demonstrated that anterior chamber depth is negatively and positively correlated with lens thickness(Singh, Goldberg, Graham, Sharma, & Mohsin, 2001) and axial length(Goss et al., 1997)(Chang et al., 2001). However no correlation was found between corneal power and ACD, as well as CP and LT in our study.

Potential limitations of our study should be mentioned. First, we measured only the anterior corneal curvature radius while the posterior corneal curvature radius was not assessed. The study could therefore address only the corneal refractive power anterior of the anterior corneal surface, but not the total refractive power of the cornea. Second, the study discussed only female subjects and did not consider the effect of gender. Further research is therefore encouraged to study the effect of gender on these correlations. Third, our study may not be representative for the whole population of Palestinian children, due to the limited age range and single gender.

CONCLUSIONS :

A population profile of axial ocular parameters was established in Palestinian female children (aged 13-15 years) for the first time. There is a significant negative correlation between corneal power and axial length in emmetropic young females aged 13 to 15 years in Gaza. Central corneal thickness, anterior chamber depth and lens thickness did not show any significant correlation with corneal power. Our study suggests that anterior curvature corneal power decreases with an increase in axial length. Findings of this study can be used as a reference for diagnostic and clinical purposes .

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Tables:

Table 1: Descriptive statistics of the variables investigated in the study.

Variable	Age (years)	K-Avg (D)	CCT (µm)	AL (mm)	ACD (mm)	Lens thickness (mm)
MD	13 and 15	43.41 ± 1.49	543.58 ± 36.77	22.76 ± 0.78	3.36 ± 0.27	3.54 ± 0.18

Abbreviations: D: Diopter; K-Avg: mean anterior curvature corneal power; AL: Axial length; LT: Lens thickness; mm: millimetres؛
CCT: Central corneal thickness; µm: micrometers; ACD: anterior chamber depth.
MD: Mean ± standard deviation.

Figures:

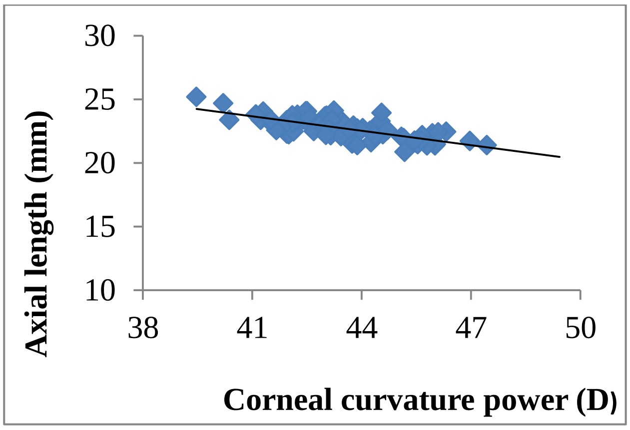

Figure 1: There was a significant negative correlation between anterior curvature corneal power and axial length (r=-0.687, p<0.05)

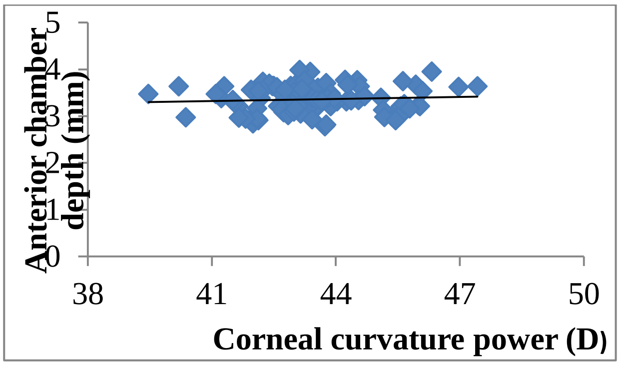

Figure 2: The correlation between anterior corneal curvature power and anterior chamber depth was insignificant (r=0.080, p=0.439)

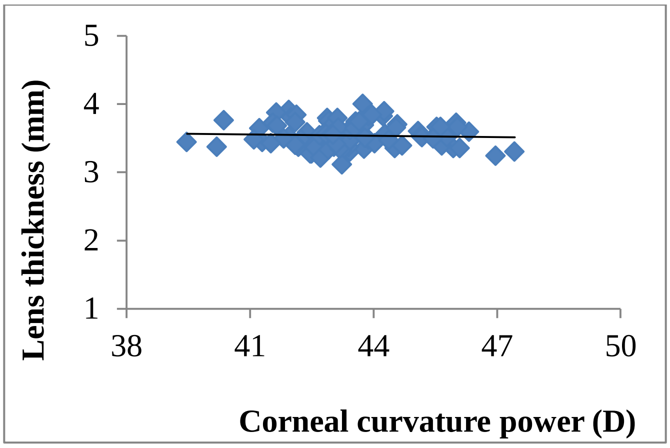

Figure 3: The correlation between anterior corneal curvature power and lens thickness was insignificant (r=-0.002, p=0.986).

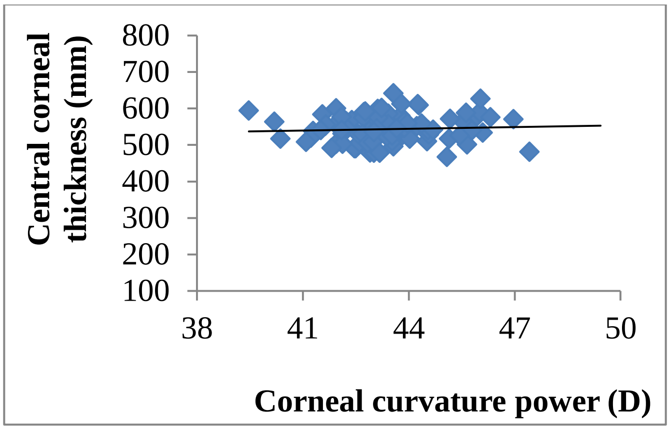

Figure 4: The correlation between anterior corneal curvature power and central corneal thickness was insignificant (r=0.107, p=0.298.)

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العلاقة بين قوة انحناء السطح الأمامي للقرنية (CP) والأبعاد المحورية للعين في العيون السليمة عند الأطفال الأصحاء في محافظات غزة

الملخص

أهداف الدراسة: هدفت البحث إلى دراسة العلاقة بين قوة انحناء السطح الأمامي للقرنية (CP) والأبعاد المحورية للعين في العيون السليمة عند الأطفال الأصحاء في محافظات غزة.

آلية البحث: تمت دراسة ستة وتسعون عين سليمة من الأطفال الإناث الأصحاء اللاتي يتراوح أعمارهن بين 13 – 15 عاماً بمتوسط حسابي (14 ± 1.00 عاماً) وكانت طبيعة الدراسة مقطعية حيث تم دراسة المتغيرات التالية: قوة انحناء السطح الأمامي للقرنية (CP) ، وسُمك القرنية المركزي (CCT) ، والطول المحوري للعين (AL)، وعمق الحجرة الأمامية (ACD) ، وسُمك العدسة البلورية .(LT).

النتائج : وقد كان متوسط قيم النتائج بين قوة انحناء السطح الأمامي للقرنية (CP)، وسُمك القرنية المركزي (CCT) ، والطول المحوري للعين (AL) كالتالي: LT (43.41 ± 1.49 D)، (543.58 ± 36.77 μm)، (22.76 ± 0.78 ملم) ، (3.36 ± 0.27 ملم) و (3.54 ± 0.18 ملم) على التوالي، وقد ظهر ارتباطاُ سلبياُ كبيراً بين قوة انحناء السطح الأمامي للقرنية (CP) والطول المحوري للعين ((r = -0.687) (AL، p <0.05)) ومع ذلك لم تظهر أي من المتغيرات الأخرى التي تم دراستها أي علاقة ذات دلالة إحصائية مع قوة انحناء السطح الأمامي للقرنية.(CP)

الاستنتاج: استنتج الباحثون أن قوة انحناء السطح الأمامي للقرنية (CP) تتناسب تناسباً عكسياً مع الطول المحوري للعين (AL) ، يمكن استخدام نتائج البحث كمرجع لأغراض تشخيصية و علاجية.

الكلمات المفتاحية: قوة انحناء القرنية الأمامية ، سمك القرنية المركزي ، الطول المحوري ، عمق الحجرة الأمامية ، سمك العدسة الشجيرات، مدينة غزة.