Ultrasonographic Measurement of Ocular Refractive Components in Eyes with Various Refractive States

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SUMMARY

Ultrasonographic measurements were done by contact technique in 231 eyes of 118 patients with the ages varying between 20 and 40. Patients were classified in to 5 groups according to their refraction states; high myopia, myopia, emmetropia, hypermetropia and high hypermetropia.

Parameters like axial eye length, anterior chamber depth, antero-posterior lens diameter and vitreus length were measured with aut^biometric method using "Teknar Ophthasonic A-Scan/B-Scan III Unit". In all groups, a significant positive correlation between vitreous length and axial length was determined (p<0.001). In emmetropic eyes, there was a significant positive correlation between anterior chamber depth and axial length (p<0.001). There was, generally, a negative correlation both in between lens thickness and axial length, and in between lens thickness and anterior chamber depth. In myopic eyes, statistically sigificant positive correlation was determined between refractive state and axial length (p<0.001). While the average axial length in emmetropic eyes was determined as 23.19 mm, It was seen that there was a wide variation in axial length (4.35 mm).

When our results were evaluated together with literature, we came to a conclusion that the most important parameter determining the refraction is axial eye length and the vireous length that is the component of axial length.

Key Words: Ultrasonographic measurement, Axial length. Anterior chamber depth, Lens thickness, Vitreous length, Refraction

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ÖZET

20-40 yaşları arasındaki 118 hastanın 231 gözünde kontakt tekniği ile ultrasonografik ölçümler yapıldı. Bu hastalar refraksiyon durumuna göre 5 gruba ayrıldı: Yüksek miyopi, miyopi, emetropi, hipermetropi ve yüksek hipermetrop!.

Aksiyel göz uzunluğu, ön kamara derinliği, antero-posterior lens çapı ve vitreus uzunluğu gibi parametreler "Teknar Ophthasonic A-Scan/B-Scan III Unit" kullanılarak otobiyomelrik metodla ölçüldü. Tüm gruplarda vitreus uzunluğu ile aksiyel uzunluk arasında anlamlı bir pozitif ilişki bulundu (p<0.001). Emetropik gözlerde ön kamara derinliği ile aksiyel uzunluk arasında anlamlı bir pozitif ilişki vardı (p<0.001). Lens kalınlığı ve ön kamara derinliği ile lens kalınlığı ve aksiyel uzunluk arasında genellikle negatif bir ilişki mevcuttu. Miyop gözlerde refraktif durum ile aksiyel uzunluk arasında istatistiksel olarak anlamlı pozitif bir ilişki bulundu (p<0.001). Emetropik gözlerde ortalama aksiyel uzunluğun 23.19 mm olarak belirlenmesine rağmen geniş bir varyasyon görülmüştür (4.35 mm).

Sonuçlarımız literatürle kıyaslandığında refraksiyonu belirleyen eh önemli parametrenin aksiyel göz uzunluğu ve vitreus uzunluğu olduğu sonucuna vardık.

Anahtar Kelimeler: Ultrasonografik ölçüm, Aksiyel uzunluk, Ön kamara derinliği, Lens kalınlığı, Vitreus uzunluğu, Refraksiyon

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Introduction

It has been accepted that refractive errors have generally originated from the abnormalities in the axial length. Practical studies have revealed that hypermetropic eyes have short, myopic eyes have long and as an ideal length emmetropic eyes have 23-24 mm of length.

Twentieth century has been the witness of new progressions about the in vivo ocular measurements. In 1938, Rushton measured the axial length of the eye by radiologic techniques and then another axial length measurement method so called optic method was described. But these methods were impractical, complex and time consuming methods. For these reasons they left their places to a faster, reliable and quick method so called "ultrasonography". Today, axial length measurements and ocular refractive components can quickly be measured with approximately hundered percent accuracy by a non-invasive ultrasonographic method (1,2).

In this study, we aimed to review the relation of the refractive state of the eye with axial length and other ocular components by measuring the anterior chamber depth, antero-posterior lens diameter, vitreous length and the axial eye length ultrasonographically in patients with different refractive states. Moreover we tried to search the correlation between the axial length and the other components.

Material and Methods

Totally 231 eyes of 118 patients were included in to study. 74 of patients were male (62.7%) and 44 were female (37.3%). The ages were varying between 20-40, average age was 26.77. Patients were classified into 5 groups as follows: High myopias above -5D (Diopter), myopic patients between -5D and -1D, patients accepted as emmetropia between -1D and +1D, patients between +1D and +5D, and high hypermetropic patients above +5D. Patients having significant ophthalmologic pathology, transparent media opacity and the patients having more than 0.5D astigmatism were not included in to the study. In patients who have less than 0.5D astigmatism, in accordance with literature, vertical meridian was used in order to measure the refraction (3). Initially patients were passed from a complete ophthalmologic examination including streak rhinoscopy. Cycloplegia was not performed. Later on biometric measurement was done. Measurements were done with "Teknar Ophthasonic A-Scan/B-Scan-III Unit". By autobiometric method, 5 measurements were done and average of them was found.

In order to find the exact length of the optic system, 0.40 mm was added to the values of axial length found before (3-6). But this addition was not done to the results of components out of axial length.

Findings

Number of measured eyes in 5 different refractive groups with the values of anterior chamber average depth, lens thickness, vitreous length, axial eye length and the results of statistical significance between these values are given in Table 1.

The degree of significance of the differences between the myopic eyes, emmetropic eyes and hypermetropic eyes were determined by unpaired t-test. Between ocular parameters correlation test was done. The significance degrees of correlation tests are shown in Table 3.

Discussion

Until the 20[th] century in vivo measurement of both axial length of human eye and the other ocular components couldn't have been done. It has become possible to perform these procedures since the ultrasonography has been begun to be used in opthalmology, and initially used relatively simpler ultrasonic units has shown a rapid technological development up to now (7-11). The biometry unit that we have used in our study is the production of new technology and it is used for both diagnostic and biometric purposes.

Results of anterior chamber depth

We, in emmetropic eyes, have found anterior chamber depth as 3.08 mm averagely (Min. 2.25 mm, max. 4.06 mm, Table 1). In literature, for the same

Table 1. Ultrasonographic measurements of ACD and LD, and the results of statistical significancy in various refractive eyes.

	n	ACD (mm)* (SD)	LD (mm)** (SD)	Average refraction
-5 D up	23	3.45 (0.38)	3.84 (0.35)	-11.37 (4.77)
(-5H-1) D	53	3.46 (0.26)	3.71 (0.24)	-3.13(1.18)
(•1)-M)D	129	3.08 (0.36)	3.83 (0.28)	-0.14(0.41)
(+1)-(+5) D	16	2.87 (0.32)	3.89 (0.46)	+2.41 (1.05)
+5 D up	7	2.93 (0.50)	4.03 (0.86)	+8.57 (3.87)
Variance analysis test:	p<0.0001	0.025<p<0.05		

ACD* : Anterior Chamber Depth.
LD" : Lens Diameter
SD : Standard Deviation

Table 2. Ultrasonographic measurements of vitreous length and axial length, and the results of statistical significancy in various refractive eyes.

	n	VL (mm)* (SD)	AL (mm)" (SD)	Average refraction
-5 D up	23	19.65 (2.02)	27.33 (1.98)	-11.37(4.77)
(-5M-1) D	53	16.93 (0.79)	24.50 (0.77)	-3.13(1.18)
(-1)-(+1)D	129	15.89 (0.86)	23.19 (0.92)	-0.14(0.41)
(+1)-(+5) D	16	14.73 (1.13)	21.89 (0.83)	+2.41 (1.05)
+5 D up	7	12.87 (2.25)	20.24(1,85)	+8.57 (3.87)
Variance analysis test:	p<0.0001	p<0.0001		

VL* : Vitreous Length
AL** : Axial Length.
SD : Standard Deviation

Table 3. Unpaired t-test results between myopic, emmetropic and hypermetropic eyes.

	Myop./Emm.	Emm./Hyper.	Myop./Hyper.
ACD*	t-7.563	t-2.301	1=7.507
	p<0.0005	0.01<p<0.025	p<0.0005
Lens Diameter	t--1.851	t=-1.392	t--2.079
	0.025<p<0.05	0.05<p<0.1	0.01<p<0.025
Vitreous Length	t-10.054	t-7.336	t»8.502
	p<0.0005	p<0.0005	p<0.0005
Axial Length	M 1.334	1=7.939	t=9.655
	p<0.0005	p<0.0005	p<0.0005

*ACDD: Anterior Chamber Depth.

age group, anterior chamber depth is reported between 2.91 -3.74 mm, and most of these values are between 3.56-3.74 mm. The reason that we have found the anterior chamber depth in lower degrees is, while in other studies immersion method has been used, in our study contact method was used and besides these cycloplegia was not performed.

Francois and Goes have found average difference of 0.42 mm between myopic and emmetropic eyes and 0.37 mm between hypermetropic and emmetropic eyes (5). In our study in accordance with literature, it was found that anterior chamber depth of emmetropic eyes have shown significant difference from myopic and hypermetropic eyes. But as the degree of refraction error in high myopics and in hypermetropics increases, the increase seen in anterior chamber depth parallel to axial length, begins to disappear (Table 1).

With variant analysis test it is seen that there is a significant difference between anterior chamber depth values of five groups (Table 1). But as it is also seen in Table 1 that there is no significant difference between two myopic groups and also between two hypermetropic groups. For this reason, we performed unpaired t-test between 3 groups by gathering the myopic eyes in to one group and hypermetropic eyes in to another group (myopic, hypermetropic and emmetropics). Here also it is seen that emmetropic eyes have significantly different anterior chamber depths rather than myopics and hypermetropics (Table 3).

In our study, in accordance with literature (5,6,10) there is a significant positive correlation between anterior chamber depth and axial length in emmetropic eyes (Table 4). In myopic and emmetropic eyes it was found that there is a significant negative correlation between anterior chamber depth and lens thickness ($p<0.001$). Due to less number of case, significant negative. correlation is not seen in hypermetropic eyes, but the correlation factor is negative. This is due to the reality of lowering effect of increasing lens thickness on anterior chamber depth.

Lens thickness results

In this study we have found that average lens thickness in emmetropic eyes was 3.83 mm (Min. 3.2, Max. 4.7 mm). In literature for the same age group lens thickness is reported between 3.61 -3.76 mm (6,12). Our results are in accordance with literature. Because of being done no cycloplegia a mild elevation in our results is seen. There are different ideas about the relation between lens thickness and refraction. There is no complete common idea about this issue. In our study, a negative correlation was found between

Table 4. Correlation test results between ocular parameters.

	n	ACD/AL	ACD/LD
-5 D up	23	r=-0.459	r--0.693
		t=2.367	t=4.404
		p<0.05	p<0.001
(-5M-1) D	53	r~+0.08	r-0.473
			(=3.833
			p<0.001
(-I)-(+I)D	129	r=+0.598	r--0.499
		t=8.410	t=6.488
		p<0.001	p<0.001
(+n-(+5) D	16	r=+0.221	r=-0.216
		t-0.848	t-0.827
+5 D up	7	r=+0.740	r=-0.380
		t=2,462	t=0.927

Note: p values which are not writen are greater more than 0.05.

ACD : Anterior Chamber Depth.
LD : Lens Diameter
AL : Standard Deviation

Table 5. Correlation test results between ocular parameters.

	n	LD/AL	VL/AL	AL/Refraction
-5 D up	23	r=+0.446	r=+0.990	r=+0.860
		t=2.283	t=31.305	t=7.726
		p<0.05	p<0.001	p<0.001
(-5)-(-1)D	53	r=+0.0004	r=+0.946	r=+0.501
			t-20.784	t-4.131
			p<0.001	p<0.001
MM+1)D	129	r=-0.358	r=+0.929	r=-0.192
		t=4.319	t=28.394	t=2.204
		p<0.001	p<0.001	
(+1)-(+5)D	16	r=-0.595	r=+0.914	r=-0.257
		t=2.769	t-8.421	t-1.649
		p<0.05		
+5 D up	7	r--0.742	r=+0.940	r=-0.784
		1=2.476	t=6.181	t=2.827
		p<0.05	p<0.001	p<0.05

Note: p values which is not write are greater more than 0.05.

ACD : Anterior Chamber Depth.
LD ; Lens Diameter
AL : Standard Deviation

lens thickness and axial length, in emmetropic eyes (p<0.001). In hypermetropic eyes there is a milder negative correlation (p<0.05) and in myopic eyes no such a correlation was seen, even also there was a slight positive correlation in between high myopias (Table 5). As it is seen that this negative correlation, which is significant in emmetropic eyes, decreases and disappears proportionally as it is deviated from emmetropy.

In emmetropic and myopic eyes, a significant negative correlation was found between lens thickness and anterior chamber depth (Table 4). In hypermetropic eyes probably due to the less number of case no statistical significance can be seen but r values are negative. Negative correlation between lens thickness and anterior chamber depth, were also shown by other authors.

As it is seen, even cycloplegia was not used in our study lens thickness values found, are in accordance with literature. But in addition to all these, in. order to reach to more accurate and more certain decisions, the benefits of studies with cycloplegia is obvious.

Vitreous length results

In emmetropic eyes we have found the average vitreous length as 15.89 mm (Min. 14.00, Max. 17.8 mm). This result is significantly in accordance with the findings in literature (Average 15.92 mm).

It is seen that there is significant statistical difference between the vitreous length of 5 refractive groups (Table 2, p<0.0001). Similarly when the patients are divided in to 3 groups as myopic, emmetropic and hypermetropic, with unpaired t-test, a significant difference between groups appears (Table 5, p<0.0005).

In all 5 groups between vitreous length and axial length, a very significant correlation was defined statistically. As it is seen Table 5. r factor is not below +0.9 in any group. Significance degree in all groups is very high (p>0.0001). These results are in accordance with literature significantly.

As it is seen in table, the positive correlation between vitreous length and axial length is the most prominent one within the ocular components. As it is same in literature, this shows that the most important component determining refraction within the axial length is vitreous length (13-15).

Axial length measurements

In previous studies, reported average axial length in emmetrops vary between 23.2 and 23.5 mm (5). We also in our study determined axial length as 23.19 mm in emmetropic eyes. It is seen that these results are in accordance with the previous reports. In most of the performed studies, it is reported that in axiai length of emmetropic eyes there is a significant degree of va- • nations up to 5 mm (5). In our study the extreme values are between 21.13 mm and 25.58 mm, and the variation amount is 4.35 mm. This result confirms the literature results.

In this study, there seems to be a significant difference between axial lengths of groups in the variance analysis test, performed (p<0.0001). Similarly, the results of unpaired t-test. performed seperately between 3 groups (the myopic, emmetropic and hypermetropic eyes) also show that there are significant differences between groups (p<0.0005). According to these results, it is seen that in order to determine the refraction, axial length plays a very important role.

As the correlation test between axial length and the refractive state of eye is done, it is seen that there is a positive correlation in myopic eyes (p<0.001) and negative correlation in high hypermetropic eyes. In emmetrophic eyes, any correlation was not observed (Table 5). The reason for not to see correlation between axial length and refraction in emmetropic eyes is the wide variation mentioned above in emmetrops.

In various reports, it is mentioned that a 1 mm change in axial length can cause 3 Diopter alteration in the refractive power (16). In our study we compared axial length and refraction averages of various refractive groups. As a result we've observed that a variation of 1 mm in axial length corresponds to a change of 2.5-3 Dioptries. This is a finding which is in accordance with classical knowledge.

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