A Comparative Study of Higher order Aberrations between Pterygium and Non-Pterygium Eyes

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Background: *Pterygium may induce pressure and distortion on the corneal surface leading to ocular aberrations.*
Objective: *To evaluate higher order aberrations in pterygium eyes.*
Material and Method: *Thirty-two patients with unilateral primary pterygium were enrolled. Wavefront analysis technique was used to determine the higher order aberrations in pterygium eyes and normal fellow eyes in individuals. Higher order aberration values were compared between both eyes with paired t-test. Pearson correlation was used to assess the correlations of higher order aberration values with pterygium size.*
Results: *Of the 32 patients, there were 15 males (47%) and 17 females (53%), mean age was 48.9±12.2 years. The average horizontal size of pterygium was 2.6±0.9 millimeters. For pterygium eyes, the mean of coma, trefoil, spherical aberration, and quadrafoil were 0.87±1.01, 1.45±1.55, 0.28±0.27, and 0.79±0.94 micrometers, respectively. And those of normal fellow eyes were 0.46±0.37, 0.80±0.71, 0.15±0.33, and 0.39±0.47 micrometers, respectively. Comparing between pterygium and contralateral normal eyes, a significant difference was present in all parameters (paired t-test, $p<0.05$). Coma, trefoil, and quadrafoil of pterygium eyes had a significant relationship with pterygium size (Pearson correlation, $p<0.05$) except for spherical aberration.*
Conclusion: *The findings suggest that higher order aberrations have a tendency to increase in pterygium eyes compared to contralateral normal eyes, and most have a correlation with pterygium size.*

Keywords: *Pterygium, Size of pterygium, Wavefront analysis, Higher order aberrations*

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Pterygium is a proliferation of fibrovascular tissue extending on the cornea. Blurred vision is one of important problems in pterygium patients. In advanced cases, impaired vision can occur as a result of pterygium growing directly to cover the pupil. But in mild cases, pterygium may also cause visual impairment indirectly by inducing pressure and distortion of the corneal surface leading to ocular aberrations.

Ocular aberrations are generally composed of two major components known as lower and higher order aberrations. There are many studies about the effect of pterygium on corneal astigmatism which is one of the lower order aberrations[1-10]. But there were not much data regarding to higher order aberrations and this disease[11,12].

The objective of the present study was to measure the higher order aberrations in unilateral primary pterygium patients by comparing the pterygium eyes with the normal fellow eyes in the same patient, and to find their correlation to the size of pterygium.

Material and Method

A prospective comparative study of 32 patients with unilateral primary pterygium was performed at Department of Ophthalmology, Thammasat Hospital from May to October 2015. Patients with corneal scar, corneal ectatic disorders, cataract, glaucoma, and history of previous ocular surgery were excluded from this study.

Size in millimeters of pterygium was measured from limbus to apex of pterygium on a horizontal axis. Wavefront analysis was performed with Wave Light Analyzer II, Alcon Inc., Switzerland.

At a 95% confidence interval, higher order

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aberration values including coma, trefoil, spherical aberration, and quadrafoil were analyzed by paired t-test comparing the pterygium eyes and the normal fellow eyes. Pearson correlation was used to assess the correlations of higher order aberration values with the size of pterygium.

This research has been approved by the Ethics Committee of Thammasat University, Thailand. Informed consent was obtained from all participants. The authors verified that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during this research, adhering to the tenets of the Declaration of Helsinki.

Results

Of the 32 patients, there were 15 males (47%) and 17 females (53%) with mean age of 48.9±12.2 years. Mean pterygium size was 2.6±0.9 millimeters. The mean of coma, trefoil, spherical aberration, and quadrafoil in pterygium eyes: normal fellow eyes were 0.87±1.01: 0.46±0.37, 1.45±1.55: 0.80±0.71, 0.28±0.27: 0.15±0.33, and 0.79±0.94: 0.39±0.47 micrometers, respectively. All parameters were statistically significant difference (paired t-test, $p<0.05$) comparing pterygium and contralateral normal eyes (Table 1).

Coma, trefoil and quadrafoil in pterygium eyes significantly correlated with pterygium size (Pearson correlation, $p<0.05$) (Table 2). Whereas spherical aberration had no correlation with the size of pterygium (Pearson correlation, $p = 0.183$) (Table 2).

Discussion

The impact of pterygium on vision was shown in the study of Gumus et al, uncorrected visual acuity values were found to be statistically lower in the pterygium group, but best corrected visual acuity values in pterygium group were comparable to normal control group. This means that pterygium may cause correctable refractive errors and low uncorrected visual acuity[12]. One of the important causes of visual impairment is ocular aberrations.

The present study found that all parameters of higher order aberrations, including coma, trefoil, spherical aberration, and quadrafoil, were significantly higher in pterygium eyes than in controlled normal fellow eyes. These findings were similar to other previous studies. Pesudovs et al reported that pterygium eyes had an increase in all Zernike aberrations especially trefoid[13]. Gumus et al also detected that all important parameters of ocular aberrations including coma ($p<0.001$), trefoil ($p<0.001$), spherical aberration ($p = 0.004$), and quadrafoil ($p<0.001$), were significantly higher in pterygium group than in control non-pterygium group[12]. Similarly, Zare et al found that not only total higher order aberrations significantly increased in the pterygium eyes compared with the normal fellow eyes ($p = 0.001$), but also all Zernike orders aberrations were significantly higher in the pterygium eyes except for spherical aberration[11].

After excision of pterygium, the corneal surface became smoother[7,8,10]. Many previous studies[13-16] showed that higher order aberrations had a tendency to decrease after pterygium surgery. A high value of higher order aberrations in pterygium eyes should be of concerned to clinicians as it may be another indication for surgery.

Table 1. Mean values (micrometers) of higher order aberrations in pterygium and normal fellow eyes

Higher order aberrations	Pterygium eyes (n = 32)	Normal fellow eyes (n = 32)	*p* (paired t-test)
Coma	0.87±1.01	0.46±0.37	0.045
Trefoil	1.45±1.55	0.80±0.71	0.046
Spherical aberration	0.28±0.27	0.15±0.33	0.039
Quadrafoil	0.79±0.94	0.39±0.47	0.041

Table 2. The correlation coefficients of higher order aberrations and pterygium size (n = 32)

Higher order aberrations	Pearson correlation coefficients	*p*
Coma	0.527	0.002
Trefoil	0.467	0.007
Spherical aberration	0.241	0.183
Quadrafoil	0.360	0.043

Our results demonstrated that most of the higher order aberrations had a significant relation with the size of pterygium except for spherical aberration. This was corresponding with the previous studies. Zare et al also found that all wave front aberrations significantly increased with pterygium size except for spherical aberration[11]. Moreover, the study of Gumus et al indicated that most values of ocular aberrations strongly correlated with both horizontal and vertical length of pterygium (p<0.001), whereas spherical aberration had a little less correlation with them (p<0.004)[12].

In the present study, the authors used only horizontal size of pterygium. It may not represent the true size of the whole pterygium. In addition, we should always keep in mind that corneal aberrations may not be affected by the pterygium size alone, but it may depend on the size of cornea too. This means the same size of pterygium in different size of cornea may cause different amount of corneal aberration.

In the future, further studies should evaluate the size of pterygium in other aspects such as both horizontal and vertical length, area of pterygium, or any ratio of pterygium size relative to cornea, which may imply more accurate results.

Conclusion

Higher order aberrations have a tendency to increase in the pterygium eyes compared to the normal fellow eyes, and most of aberrations have a correlation with pterygium size.

What is already known on this topic?

1) Pterygium increased higher order wavefront aberrations for all Zernike orders, except for spherical aberration in some studies.

2) Amount of corneal aberrations correlate with size of pterygium.

What this study adds?

1) Confirms previous studies that pterygium significantly increases higher order aberrations (coma, trefoil, spherical aberration, and quadrafoil).

2) Confirms the correlation between higher order aberrations and size of pterygium.

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Potential conflicts of interest

None.

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การศึกษาเปรียบเทียบการเห็นผิดเพี้ยนระดับสูงระหว่างตาที่เป็นต้อเนื้อและไม่เป็นต้อเนื้อ

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ภูมิหลัง: ต้อเนื้ออาจมีผลต่อการกดทับผิวกระจกตาและทำให้ผิวกระจกตาเกิดการบิดเบี้ยว นำไปสู่การมองเห็นที่ผิดเพี้ยน

วัตถุประสงค์: เพื่อประเมินการเห็นผิดเพี้ยนระดับสูงในตาที่เป็นต้อเนื้อ

วัสดุและวิธีการ: ศึกษาในผู้ป่วยทั้งหมด 32 รายที่มีต้อเนื้อในตาข้างเดียว วิเคราะห์การเห็นผิดเพี้ยนระดับสูงด้วยวิธี Wavefront และเปรียบเทียบระหว่างตาที่มีต้อเนื้อกับตาอีกข้างที่ไม่มีต้อเนื้อในผู้ป่วยแต่ละรายโดยสถิติ paired t-test ใช้สถิติ Pearson correlation เพื่อหาความสัมพันธ์ระหว่างค่าการเห็นผิดเพี้ยนระดับสูงและขนาดของต้อเนื้อ

ผลการศึกษา: ในผู้ป่วย 32 ราย เป็นชาย 15 ราย (ร้อยละ 47) หญิง 17 ราย (ร้อยละ 53) มีอายุเฉลี่ย 48.9±12.2 ปี ขนาดเฉลี่ยของต้อเนื้อในแนวนอนเท่ากับ 2.6±0.9 มิลลิเมตร ค่าเฉลี่ยของ coma, trefoil, spherical aberration, และ quadrafoil ในตาที่เป็นต้อเนื้อเท่ากับ 0.87±1.01, 1.45±1.55, 0.28±0.27, และ 0.79±0.94 ไมโครเมตร ตามลำดับ และค่าเฉลี่ยดังกล่าวในตาอีกข้างที่ปกติคือ 0.46±0.37, 0.80±0.71, 0.15±0.33, และ 0.39±0.47 ไมโครเมตร ตามลำดับ เมื่อเปรียบเทียบตาที่เป็นต้อเนื้อและตาอีกข้างที่ปกติ พบว่าค่าเฉลี่ยทุกชนิดที่กล่าวมา มีความแตกต่างอย่างมีนัยสำคัญ (paired t-test, $p<0.05$) ค่าของ coma, trefoil, และ quadrafoil ในตาข้างที่เป็นต้อเนื้อ มีความสัมพันธ์กับขนาดของต้อเนื้ออย่างมีนัยสำคัญ (Pearson correlation, $p<0.05$) ยกเว้น spherical aberration

สรุป: ค่าการเห็นผิดเพี้ยนระดับสูงมีแนวโน้มที่จะเพิ่มในตาที่เป็นต้อเนื้อเมื่อเปรียบเทียบกับตาที่ไม่เป็นต้อเนื้อ และส่วนมากมีความสัมพันธ์กับขนาดของต้อเนื้อ