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Central foveal distribution based on posterior scleral morphologies in high myopia

Wei-Feng Liu[1], Jiang-Bo Fan[2], Yue-Yuan Xu[1], Xuan Zhu[1], Ya-Lan Ming[1], Yi-Qi Liu[1], Xue-Li Lan[1], Guo-Fu Huang[1]

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[1]Department of Ophthalmology, the Third Affiliated Hospital of Nanchang University (The Eye Hospital of Nanchang, Zhongshan Ophthalmic Center, Sun Yat-Sen University), Nanchang 330000, Jiangxi Province, China

[2]Department of Ophthalmology, No. 1 People's Hospital of Xiushui County, Xiushui 332400, Jiangxi Province, China

Correspondence to: Guo-Fu Huang. Department of Ophthalmology, the Third Affiliated Hospital of Nanchang University (The Eye Hospital of Nanchang, Zhongshan Ophthalmic Center, Sun Yat-Sen University), Nanchang 330000, Jiangxi Province, China. hgf2222@sina.com

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高度近视眼不同后巩膜形态黄斑中心凹分布研究

刘维锋[1],樊江波[2],徐月圆[1],朱　璇[1],闵亚兰[1],刘毅琦[1],兰雪莉[1],黄国富[1]

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(作者单位:[1]330000 中国江西省南昌市,南昌大学第三附属医院眼科(中山大学中山眼科中心南昌眼科医院);[2]332400 中国江西省修水县第一人民医院眼科)

作者简介:刘维锋,毕业于南昌大学,硕士研究生,主任医师,研究方向:眼底病。

通讯作者:黄国富,毕业于中山大学,博士研究生,主任医师,教授,研究方向:角膜病及屈光手术. hgf2222@sina.com

摘要

目的:研究高度近视眼黄斑中心凹在不同后巩膜形态的分布。

方法:收集2016-05/2018-02南昌大学第三附属医院高度近视患者126例207眼,按照Curtin的后巩膜形态分类方法分为三组:A组为Ⅰ和Ⅱ型后巩膜形态眼,B组为Ⅲ型后巩膜形态眼,C组为Ⅶ、Ⅸ、Ⅹ型后巩膜形态眼。将眼底后极部区域分为1、2、3区域。测量中心凹至通过视盘中心垂直线的水平距离(HDFCO)、中心凹至通过视盘中心水平线的垂直距离(VDFCO)和视力。研究在高度近视不同后巩膜形态中心凹位置的分布。

结果:在后极部1区,3眼(1.5%)均来自A组。在后极部2区,117眼(56.5%)来自A组,15眼(7.2%)来自B组,13眼(6.3%)来自C组。三组HDFCO分别为5037±507、4771±509、5585±773μm(F=8.38,P<0.01)。三组VDFCO分别为615±297、643±322、504±363(F=0.87,P=0.41)。在后极部3区,43眼(20.7%)来自A组,7眼(3.4%)来自B组,9眼(4.4%)来自C组。三组HDFCO分别为5048±683、4444±540、5293±840(F=3.13,P=0.05)。三组VDFCO分别为1385±484、1225±201、1664±318μm(F=2.18,P=0.12)。中心凹位于2区和3区的高度近视眼平均最佳矫正视力(LogMAR)分别为4.87±0.22和4.77±0.27(t=-1.55,P=0.12)。

结论:高度近视眼黄斑中心凹位置在不同后巩膜形态中发生轻微变化,对最佳矫正视力无影响。

关键词:高度近视;后巩膜形态;中心凹;视力

Abstract

• AIM: To describe the distribution of the central fovea macula in different zones of the eye fundus and different posterior scleral morphologies in high myopia (HM).

• METHODS: From May 2016 and February 2018, a total of 207 eyes (126 cases) with HM were selected and divided into three groups according to Curtin's posterior scleral staphyloma classifications: group A (Types Ⅰ and Ⅱ), group B (Type Ⅲ), and group C (Types Ⅶ, Ⅸ, and Ⅹ). The posterior zone of the fundus was divided into three zones: zones 1, 2 and 3. The horizontal distance between the central fovea and the vertical line pass of the optic nerve head (ONH) center (HDFCO), the vertical distance between the fovea and the horizontal line pass of the ONH center (VDFCO), and vision were tested. The fovea position in different posterior scleral morphologies groups were investigated.

• RESULTS: In zone 1, 3 eyes were all from group A (1.5%). In zone 2, 117 eyes were from group A (56.5%), 15 eyes were from group B (7.2%), and 13 eyes were from group C (6.3%). The HDFCO was 5037±507 μm, 4771±509 μm, and 5585±773 μm in groups A, B, and C, respectively (F=8.38, P<0.01). The VDFCO values were 615±297 μm, 643±322 μm, and 504±363 μm (F=0.87, P=0.41). In zone 3, 43 eyes were from group A (20.7%), 7 eyes were from group B (3.4%), and 9 eyes were from group C (4.4%). The HDFCO was 5048±683 μm, 4444±540 μm, and 5293±840 μm in groups A, B, and C, respectively (F=3.13, P=0.05). The VDFCO values were 1385±484 μm, 1225±201 μm, and 1664±318 μm (F=2.18, P=0.12). The mean best corrected visual acuity of HM group was LogMAR 4.87±0.22 and 4.77±0.27 in zone 2 and zone 3, respectively (t=-1.55, P=0.12).

• CONCLUSION: The position of the central fovea changes slightly with different posterior scleral morphologies in HM and has no effects on best corrected visual acuity.
• KEYWORDS: high myopia; posterior scleral morphology; central fovea; vision
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INTRODUCTION

With the increasing prevalence of myopia[1-3], the occurrence of high myopia (HM) is also increasing[4-6]. As HM progresses, the axial length (AL) increases and the sclera expands, resulting in different posterior scleral morphologies. Some of the most convex parts of the posterior sclera are located at the posterior pole or below, some are located at the optic nerve area, and others are mixed. Whether this change in the morphology of the posterior sclera affects the central foveal position has yet to be reported. This study used Topcon DRI-OCT to measure the horizontal distance between the fovea and the vertical line pass of the optic nerve head (ONH) center (HDFCO) and the vertical distance between the fovea and the horizontal line pass of the ONH center (VDFCO). The distribution of the fovea in the posterior zone was additionally evaluated to explore the influence and relationship of different posterior scleral morphologies.

SUBJECTS AND METHODS

Patients with refractive errors were consecutively recruited between May 2016 and February 2018 at the Third Affiliated Hospital of Nanchang University. The exclusion criteria were patients who underwent fundus surgery and patients with other ocular diseases that affected the evaluation of the foveal position. For patients with an eye AL larger than 26 mm, the 12 mm×9 mm scan mode of Topcon DRI-OCT Atlantis was used to acquire OCT images of the eye. This study included 126 cases (207 eyes): 74 females (128 eyes), 52 males (79 eyes), 110 cases of the right eye, and 97 cases of the left eye. The age range was from 7-81 (average 38.55±18.36) years, spherical equivalent (SE) from -6.00 to -31.50 (mean: -13.13±5.89) Diopters, and AL from 26-36.10 (average: 28.98±2.04) mm. The study complied with the tenets of the Declaration of Helsinki, and approval was obtained from the Institutional Review Board of the Third Affiliated Hospital of Nanchang University.

Group Classification Classification of the posterior scleral morphology was determined using the OCT-3D model. The imaging model visualized 3D images of the posterior sclera. According to Curtin's posterior scleral staphyloma classifications[7], the most common types were analyzed (Types Ⅰ, Ⅱ, Ⅲ, Ⅶ, Ⅸ, and Ⅹ). Types Ⅰ and Ⅱ were classified as group A, type Ⅲ as group B, and types Ⅶ, Ⅸ, and Ⅹ as group C. The posterior scleral morphology was evaluated and confirmed by two retina specialists. If there were any inconsistencies in the evaluations, the sample was assessed by a third specialist.

Zone Definition According to three horizontal line passes of the ONH, the posterior polar 30°eye fundus was divided into three zones. Line 1 was the horizontal line pass of the superior rim of the ONH, Line 2 was the pass of the center ONH, and Line 3 was the pass of the inferior rim of the ONH. Zone A was between Line 1 and Line 2, Zone 2 was between Line 2 and Line 3, and Zone 3 was below Line 3. (Figure 1).

Location Definition The distribution of the central fovea position was defined according to several measurements. As shown in Figure 1, the macular fovea (red intersection) and the center of the ONH (red intersection) determined the HDFCO (solid long blue line) and VDFCO (solid short blue line). Two sets of data, HDFCO and VDFCO, were used to determine the location of the fovea.

Refractive Error Refractive error was determined using computerized refractor and subjective refraction examinations. A Nidek autorefractometer ARK-1 was initially used to determine the refractive degree and other notable features. Patients (< 18 years of age) were then examined retinoscopically following an instillation of three drops of tropicamide 0.5%, which were instilled at 5-min intervals. After the instillation of the third drop (>30min), subjective refraction was performed. Patients >18 years of age were examined directly using subjective refraction. SEs were calculated following the examination. Subjective refraction was performed using a Nidek RT3100 refractometer (NIDEK CO. LTD.). Best corrected visual acuity (BCVA) were tested and recorded. The visual acuity of the myopic maculopathy C0 and C1 HM were analyzed according to META-PM classification.

Axial Length Measurement IOL Master (Carl Zeiss Meditec) was used to measure the AL 5 times. The average was taken, and if there was a deviation within the 5 measurements, the datum was not used in the study.

Statistical Analysis Descriptive analyses of the data were undertaken using SPSS 16.0 software (SPSS, Inc, Chicago, IL, USA). A one-way analysis of variance (ANOVA) was used. A probability value of less than 5% was considered statistically significant.

RESULTS

General Posterior Scleral Morphology Group There was no statistically significant difference in age, SE, or AL between groups A and B. However, the difference among groups A, B, and C was statistically significant. The width of the ONH ranged between 941 and 2424 μm, and the average was 1451±374 μm. Among them, the horizontal length of group A was shortest than that of groups B and C, and the difference was statistically significant. The vertical length of the ONH ranged between 1341 and 3176 μm, with an average of 2083±351 μm. The vertical length of group C was longer than that of groups A and B, and the difference was statistically significant (Table 1).

Table 1　Comparison of different posterior scleral morphology groups under general conditions　　$\bar{x}\pm s$

Parameters	Group A	Group B	Group C	F	P
Age (y)	36.8±18.6	40.54±15.97	49.36±15.11[a]	4.84	<0.01
SE (D)	12.65±5.21	13.38±3.96	17.89±11.10[a,b]	5.30	<0.01
AL (mm)	28.74±1.85	28.69±1.90	31.25±2.32[a,b]	13.39	<0.01
Width of ONH (μm)	1390±378	1786±201[a]	1581±251[a]	13.30	<0.01
Vertical length of ONH (μm)	2052±343	2167±308	2234±409[a]	3.38	<0.05

SE: Spherical equivalent; AL: Axial length; ONH: Optic nerve head. [a]Statistically significant for group A; [b]Statistically significant for group B.

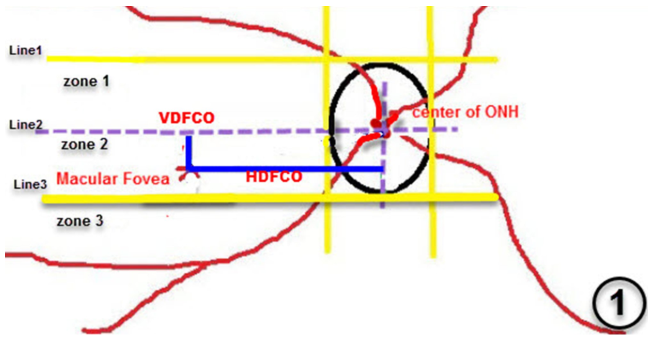

Figure 1　Distance between the central fovea and the ONH: HDFCO and VDFCO.

Parameters of the Central Foveal Position　The HDFCO ranged between 3629 and 7290 μm, with an average of 5048±608 μm. The HDFCO was 5042±555 μm, 4662±530 μm, and 5466±795 μm in groups A, B, and C, respectively. There was a statistically significant difference among the three groups (F=10.27, P<0.01). The HDFCO of group B (Type Ⅲ) was the shortest, followed by group A (Types Ⅰ and Ⅱ). The longest HDFCO is in Group C.

The VDFCO ranged between 71 and 3317 μm, with an average of 831±510 μm. The VDFCO values were 811±497 μm, 828±397 μm, and 979±674 μm in groups A, B, and C, respectively. There was no significant difference among the three groups (F=1.05, P=0.35).

The Central Foveal Position in Different Zones　Of the 207 eyes, there were 3 eyes in zone 1, accounting for 1.5% (3/207) of the samples - all of which were from group A (Type Ⅰ and Type Ⅱ). There were 145 eyes in zone 2, accounting for 70% (145/207) of the samples. A total of 117 eyes were from group A (56.5%), 15 eyes were from group B (7.2%), and 13 eyes were from group C (6.3%). There were 59 eyes in zone 3, which accounted for 28.5% (59/207) of the samples; 43 eyes were from group A (20.7%), 7 eyes were from group B (3.4%), and 9 eyes were from group C (4.4%).

In zone 2, the HDFCO was 5037±507 μm, 4771±509 μm, and 5585±773 μm in groups A, B, and C, respectively. There was a statistically significant difference among the three groups (F=8.38, P<0.01). The VDFCO values were 615±297 μm, 643±322 μm, and 504±363 μm in groups A, B, and C, respectively. There was no significant difference among the three groups (F=0.87, P=0.41).

In zone 3, the HDFCO was 5048±683 μm, 4444±540 μm, and 5293±840 μm in groups A, B, and C, respectively. There was no statistically significant difference among the three groups (F=3.13, P=0.05). The VDFCO values were 1385±484 μm, 1225±201 μm, and 1664±318 μm. There was no significant difference among the three groups (F=2.18, P=0.12).

Visual Acuity　The visiual acutiy of HM were LogMAR 4.87±0.22 and 4.77±0.27 in zone 2 and zone 3; these values were not significantly different (t=-1.55, P=0.12). The vision of HM in zone 1 was LogMAR 4.2 in just one eye.

DISCUSSION

The visual function decrease gradually in HM. Most ophthalmologies think it corrected with much factors in clinical practice, include refractive error, optical aberration in early stage and retinal structural damage, choroidal vascular reduction in late stage of HM. But all changes attribute to long AL and posterior staphyloma. Long AL and posterior staphyloma will change the macular fovea and eye position. It cause visual axis light can't focus on the macular fovea. This is a question worth discussing.

In previous qualitative and quantitative reports on the eye and retina, the morphology of the eye was rarely analyzed and taken into account. In 1977, Curtin used the first binocular indirect ophthalmoscope to classify posterior staphyloma into 10 types, providing a clinical reference for the evaluation of posterior scleral morphologies in HM. In recent years, with the development of imaging technology in ophthalmology, Ohno-Matsui reclassified posterior staphyloma into 5 categories using 3D-MRI images. This resulted in the removal of the latter 5 categories of Curtin's classifications, namely, the wide, narrow, peripapillary, nasal, and inferior types of posterior staphyloma[8]. In addition, Moriyama *et al*[9] used 3D-MRI imaging to classify the posterior segment into barrel, cylindric, nasally distorted, and temporally distorted types, whereas Fledelius *et al*[10] quantified the appearance of posterior scleral grape cysts by reconstructing curvature plots with OCT. In this study, a 3D composite image of the posterior sclera was formed using DRI-OCT Atlantis to evaluate the posterior scleral pattern. Types Ⅰ and Ⅱ were classed together into group A because it is difficult to accurately assess. Type Ⅲ was grouped into group B, and Types Ⅶ, Ⅸ, and Ⅹ were classed as group C. Types Ⅳ and Ⅴ were not observed in this study.

To analyze the distribution of the central foveal position, a reference point must be formed. Researchers have used the temporal disc, myopic arc[11-12], and optic disc[13-14] as previous reference points. The myopic arc often changes with age and AL[15]. These results showed that the widest width of the ONH was Type Ⅲ of group B, followed by group C and group A with the narrowest width. From a vertical length of the ONH, groups A, B, and C all gradually increased. This indicates that different posterior morphologies can lead to significant changes in the ONH. Therefore, in this study, the center of the ONH was established as the reference point, which was used to evaluate the position of the central fovea using HDFCO and VDFCO measurements. There were significant differences in groups A, B, and C by comparing HDFCOs. The HDFCO of Type Ⅲ of group B was the shortest, followed by Types Ⅰ and Ⅱ of group A. The longest HDFCO was found in group C. However, there were no significant differences in VDFCO among groups A, B, and C. This shows that the central fovea changes mainly in the horizontal direction in different posterior scleral morphologies, with the fovea closest to the ONH in group B.

It is evident that the central fovea of the 70% sample are normally distributed in zone 2. Approximately 30% of the samples have significant displacement in zone 1 (1.5%) and zone 3 (28.5%). A total of 1.5% of the eyes moved up to zone 1, which were mostly from the group with an AL longer than 29 mm. In zone 2, HDFCO was longest in group C than in other groups, and there was no difference between groups A and B. No difference in VDFCO among three groups, which indicates that the central fovea location mostly changes in the horizontal line and in mixed mode posterior scleral morphologies.

In zone 3, the longest HDFCO was in group C, and the shortest HDFCO was in group B. No difference in VDFCO among three groups, which indicates that the central fovea location mostly changes in the horizontal line and in mixed mode posterior scleral morphologies. The visual outcomes were determined, including refractive status, AL, and aging in HM[16]. With the progression of myopia, myopic maculopathy influences visual outcomes, including fusion of patchy atrophy, CNV, macular atrophy and lacquer cracks[17-18]. From this study, C2, C3, and C4 myopic maculopathy were excluded. The central fovea position was related to the vision of HM of C1 myopic maculopathy. Therefore, this suggests that the visual outcomes are influenced by the above factors, and the position of the fovea is not affected.

In this study, groups B and C had relatively small samples. However, aside from the limitations of this study, the age, AL, and SE of groups A and B were complementary, producing more accurate analysis results. For group C, the same factors were significantly higher than those of groups A and B. Interestingly, this in itself is a feature of the different types of posterior scleral morphologies. In summary, the position of the fovea changes horizontally with different posterior scleral morphologies in different zones in HM, but this change has no effect on vision.

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