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ORIGINAL ARTICLE

Anterior chamber characteristics assessed by rotating Scheimpflug imaging in patients with retinitis pigmentosa

Características da câmara anterior avaliadas por um dispositivo de imagem rotativo Scheimpflug em pacientes com retinite pigmentosa

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ABSTRACT | Purpose: The aim of this study was to evaluate anterior segment parameters and corneal aberrations in patients with retinitis pigmentosa using Scheimpflug imaging and to compare the findings with those for healthy controls. **Methods:** This single-center, case-control study included patients diagnosed with retinitis pigmentosa who were followed up at the Department of Ophthalmology of Kayseri Training and Research Hospital between February and June 2018. Age- and sex-matched healthy individuals with no known ophthalmologic disease formed the control group. Both patients with retinitis pigmentosa and controls underwent comprehensive ophthalmic assessments, including the measurement of the best-corrected visual acuity calculation of the spherical equivalent, slit-lamp examination, stereoscopic fundus examination, computerized visual field test, and electroretinography. Topographic and aberrometric values were measured using Scheimpflug-based tomography. **Results:** This study was performed on 52 eyes of 26 patients with retinitis pigmentosa (14 men) and 52 eyes of 26 healthy controls (11 men). The average keratometry (K_{avg}) values for the patient and control groups were similar (43.87 ± 2.23 versus 43.61 ± 1.68; p=0.546), but the maximum keratometry (K_{max}) value was significantly higher in the patient group (45.85 ± 2.35 and 44.69 ± 1.86; p=0.015). Patients with retinitis pigmentosa had a significantly lower central corneal thickness (518.5 ± 42.3 versus 534.1 ± 24.5, respectively; p=0.042) and maximal corneal thickness (509.1 ± 50.5 versus 530.5 ± 24.1, respectively; p=0.015). Additionally, the iridocorneal angle for the patients was significantly lower (31.6 ± 9.2 versus 35.9 ± 7.7, p=0.025). The aberrometric findings indicated that patients with retinitis pigmentosa had significantly more higher-order aberrations than those in the healthy controls (0.794 ± 51 and 0.398 ± 08, respectively; p<0.001). **Conclusions:** The results of the present study demonstrated that patients with retinitis pigmentosa have different anterior segment parameters and corneal aberrations compared to healthy controls. These results should be supported by further studies.

Keywords: Retinitis pigmentosa; Anterior eye segment; Corneal topography; Aberrometry

RESUMO | Objetivo: Este estudo visou avaliar parâmetros do segmento anterior e aberrações corneanas em pacientes com retinite pigmentosa através de imagens de Scheimpflug e comparar os achados com os de controles saudáveis. **Métodos:** Este foi um estudo caso-controle unicêntrico que incluiu pacientes com o diagnóstico de retinite pigmentosa em acompanhamento no Departamento de Oftalmologia do Hospital de Treinamento e Pesquisa de Kayseri, entre fevereiro e junho de 2018. Indivíduos saudáveis pareados por idade e sexo, sem nenhum conhecimento da doença oftalmológica formou o grupo controle. Ambos os pacientes com retinite pigmentosa quanto os controles foram submetidos a avaliações oftalmológicas abrangentes, incluindo a medição do cálculo da acuidade visual melhor corrigida, o cálculo do equivalente esférico, biomicroscopia, fundoscopia estereoscópica, campimetria computadorizada e eletrorretinografia. Os valores topográficos e de aberrometria foram medidos através de tomografia baseada no sistema Scheimpflug. **Resultados:** O estudo incluiu 52 olhos de 26 pacientes com retinite pigmentosa (14 homens) e 52 olhos de 26 controles saudáveis (11 homens). Os valores médios da ceratometria (K_{avg}) para grupos dos pacientes e controle foram semelhantes (43,87 ± 2,23 versus 43,61 ± 1,68, p=0,546), mas o valor máximo da ceratometria (K_{max}) foi significativamente maior no grupo de pacientes (45,85 ± 2,35 e 44,69 ± 1,86; p=0,015). Pacientes

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com retinite pigmentosa apresentaram uma espessura corneana central significativamente menor (518,5 ± 42,3 versus 534,1 ± 24,5, respectivamente; p=0,042) e espessura corneana máxima (509,1 ± 50,5 verus 530,5 ± 24,1, respectivamente; p=0,015). Além disso, o ângulo iridocorneano para os pacientes foi significativamente menor (31,6 ± 9,2 versus 35,9 ± 7,7; p=0,025). Os achados da aberrometria indicaram que os pacientes com retinite pigmentosa apresentaram significativamente mais aberrações de ordem superior em comparação com os controles saudáveis (respectivamente 0,794 ± 51 e 0,398 ± 08, respectivamente; p<0,001). **Conclusões:** Os resultados do presente estudo demonstraram que pacientes com retinite pigmentosa têm diferentes parâmetros do segmento anterior e aberrações corneanas em comparação com controles saudáveis. Estes resultados precisam ser confirmados por novos estudos.

Descritores: Retinite pigmentosa; Segmento anterior do olho; Topografia da córnea; Aberrometria

INTRODUCTION

Retinitis pigmentosa (RP), a condition characterized by primary degeneration of rod photoreceptors followed by the loss of cone photoreceptors, is the most common inherited retinal dystrophy, with a reported prevalence of 1:9,000 or 1:750, depending on the geographical location[1,2]. RP can be clinically distinguished from other inherited retinal dystrophies. Individuals with RP experience difficulties with dark adaptation, usually beginning in adolescence, followed by visual loss in the midperipheral field during young adulthood[3]. RP can affect the cornea, lens, and retina, subsequently resulting in keratoconus[4], posterior subcapsular cataract[5], and cystoid macular edema[6]. This condition has also been associated with refraction disorders[7] and angle closure glaucoma[8]. These associations suggest that anterior segment parameters and corneal aberrations in patients with RP may differ from those in the normal population. Nevertheless, to the best of our knowledge, no studies in the literature have investigated the anterior segment parameters and corneal aberrations of patients with RP.

The Scheimpflug camera is a device that can provide images of the entire anterior segment from the anterior corneal surface to the posterior lens surface[9], enabling the examination of the anterior segment parameters and corneal aberrations[10].

The aim of the present study was to evaluate the anterior segment parameters and corneal aberrations in patients with RP using Scheimpflug imaging and to compare the findings with those for healthy controls.

METHODS

Patients

This single-center, case-control study included patients diagnosed with RP who were followed up at the Department of Ophthalmology, Kayseri Training and Research Hospital, between February 2018 and June 2018. Age- and sex-matched healthy individuals with no known ophthalmologic disease admitted to the same department during the same study period formed the control group. Patients with a history of previous ocular surgery and those with herpetic keratitis, corneal opacities for any reason, other ocular diseases, or inflammation were excluded. The diagnosis of RP was established on the basis of fundoscopic examination, electroretinography, and a computerized visual field test.

Main outcome measures

Both patients with RP and controls underwent comprehensive ophthalmic assessments, including measurement of the best-corrected visual acuity (BCVA), calculation of the spherical equivalent, slit-lamp examination (biomicroscopy), stereoscopic fundus examination, and a computerized visual field test. If RP was suspected, an electroretinography test was performed. Topographic and aberrometric values (central corneal thickness [CCT], minimal corneal thickness [MCT], corneal volume, corneal curvatures (K1 and K2), anterior chamber depth, anterior chamber volume, iridocorneal angle, pupil size, and anterior higher-order aberrations [HOAs]) were measured using Scheimpflug-based tomography (Pentacam™, Oculus Inc., Lynnwood, WA, USA).

Statistical analysis

Data analysis was performed using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY, USA). The normality of the data was tested using the Shapiro-Wilk *W*-test. All data were expressed as the mean and standard deviation. An independent samples *t*-test (Student's *t*-test) was performed to assess the significance of the differences between groups. A p-value of $p<0.05$ was considered statistically significant.

RESULTS

The present study was performed on 52 eyes of 26 patients with RP (14 males, 12 females) and 52 eyes of 26 healthy controls (11 men, 15 women). The mean ages for the patient and control groups were similar (41.81 ± 15.08 years and 42.76 ± 17.56, respectively; p=0.790).

Table 1. Refractive, topographic, and pachymetric findings for the patients with RP and healthy controls.

Parameters	Patients with RP	Healthy controls	p-value*
SER, D	-1.03 ± 0.35	-0.87 ± 0.28	0.221
Anterior corneal K_{avg}, D	43.87 ± 2.23	43.61 ± 1.68	0.546
K_{max}, D	45.85 ± 2.35	44.69 ± 1.86	**0.015**
Topographic astigmatism, D	1.45 ± 1.07	1.06 ± 2.11	0.295
Posterior corneal K_{avg}, D	-6.43 ± 0.311	-6.32 ± 0.29	0.107
CCT, µm	518.5 ± 42.3	534.1 ± 24.5	**0.042**
Corneal volume, mm^3	74.87 ± 14.72	71.94 ± 11.81	0.878
MCT, µm	509.1 ± 50.5	530.5 ± 24.1	**0.015**
Iridocorneal angle, degrees	31.6 ± 9.2	35.9 ± 7.7	**0.025**

RP= retinitis pigmentosa; SER= spherical equivalent refractive errors; D= diopter; K_{max}= maximum keratometry; K_{avg}= average keratometry; CCT= central corneal thickness; MCT= minimal corneal thickness. *Student's *t*-test.

Table 2. Results of aberrometric analyses for the patients with RP and healthy controls.

Parameters	Patients with RP	Healthy controls	p-value*
Total RMS	1.945 ± 0.577	1.290 ± 0.454	**<0.001**
RMS LOAs	1.796 ± 0.539	1.214 ± 0.464	**0.001**
RMS HOAs	0.794 ± 51	0.398 ± 08	**<0.001**
Z40	0.258 ± 210	0.198 ± 0.77	**0.011**

RP= retinitis pigmentosa; RMS= root mean square; HOA= higher-order aberration; LOA= lower-order aberration; Z40= spherical aberration of the fourth order. *Student's *t*-test.

The refractive, topographic, and pachymetric findings for the patient and control groups are presented in table 1. While the average keratometry (K_{avg}) value was similar between the patient and control groups (p=0.546), the maximum keratometry (K_{max}) value was significantly higher in patients with RP than in the controls (p=0.015). CCT and MCT were found to be significantly lower in patients with RP than in the controls (p=0.042 and 0.015, respectively; Student's *t*-test). Additionally, the iridocorneal angle measured using Scheimpflug-based tomography was significantly lower in patients with RP (p=0.025). All patients were phakic, and none had undergone ophthalmic surgery. The aberrometric findings indicated that patients with RP had significantly higher HOAs than those of the healthy controls (p<0.001; Table 2).

DISCUSSION

Although studies on the choroidal thickness[11], macular thickness[12], and retinal fiber layer thickness[13] of patients with RP are available in the literature, to the best of our knowledge, there are no studies on the anterior segment parameters. The present study, investigating the anterior segment parameters and corneal aberrations in patients with RP in comparison with healthy controls using Scheimpflug imaging, revealed that K_{max}, CCT, MCT, and the anterior chamber angle were significantly different in the patients with RP. In addition, evaluation of the corneal aberrations revealed that the total root mean square (RMS), RMS lower-order aberrations (LOAs), RMS HOAs, and spherical aberrations were higher in the patients with RP than in the controls.

Keratoconus, a bilateral, asymmetric, progressive disease characterized by thinning and stiffening of the cornea[14], is more common in patients with RP[15]. In addition to case reports on the association of RP with keratoconus[16-18], it has been indicated in some studies that RP is one of the ocular risk factors for keratoconus[4,14,15]. However, there is a lack of information regarding the underlying mechanism of this association. It has been emphasized in previous studies that both diseases are related to inflammation[19,20]. Although keratoconus is recognized as a noninflammatory disease, the presence of inflammation in some patients with keratoconus has been reported in recent studies. In studies evaluating the tears of keratoconus patients, elevated levels of interleukin-6 (IL-6), tumor necrosis factor-alpha, and matrix metalloproteinase-9 were found as evidence of inflammation[21]. In some studies on humans and animals, it has also been demonstrated that high levels of inflammatory cytokines, such as IL-1 and IL-6, in patients with RP are indicative of inflammation[22]. The association between inflammation and the more frequent occurrence of keratoconus in patients with RP remains unknown; we are of the opinion that inflammation may be the cause of corneal changes in both diseases.

Corneal aberrations began to be investigated using corneal tomography devices and aberrometers. These aberrations, which are of great importance for visual performance, have been evaluated in diabetes mellitus[23], in Marfan syndrome[24], after various surgeries[25], and in dry eye disease[26]. To the best of our knowledge, there have been no studies evaluating corneal aberrations in patients with RP in the literature. In the present study, corneal aberrations were found to be higher in patients with RP than in the controls; this finding is in accordance with the impaired vision quality and visual acuity in patients with RP. Corneal involvement in patients with RP also suggests an increase in corneal aberrations. Further studies on the physiopathology are required in order to clarify this issue.

The present study has some limitations, including a small sample size and a single-center study design. Another limitation of the present study is that corneal aberrations were not assessed with aberrometry and were only assessed using Pentacam™.

In conclusion, the results of the present study demonstrated that patients with RP have different anterior segment parameters and corneal aberrations compared with healthy controls. These results warrant further investigation in future studies. In addition, the reasons underlying these results should be investigated in order to provide an understanding of the etiopathogenesis.

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