Kocatepe Tıp Dergisi
Kocatepe Medical Journal
24:388-392 /Ekim 2023 Sayısı

ARAŞTIRMA YAZISI / RESEARCH ARTICLE

PELLUSİD MARJİNAL DEJENERASYON VE KERATOKONUSUN SCHEİMPFLUG KAMERA GÖRÜNTÜLEME PATERNLERİNİN VE PARAMETRELERİNİN KARŞILAŞTIRILMASI

COMPARISON OF SCHEIMPFLUG CAMERA IMAGING PATTERNS AND PARAMETERS OF PELLUCID MARGINAL DEGENERATION AND KERATOCONUS

Ayşe Güzin TAŞLIPINAR UZEL[1] Yeşim ALTAY[1], Ahmet ŞENGÜN[2]

[1]Ufuk Üniversitesi Tıp Fakültesi, Göz Hastalıkları Ana Bilim Dalı
[2]Medicana Hastanesi, Göz Hastalıkları Kliniği

ÖZET

AMAÇ: Bu çalışma Pellusid marjinal dejenerasyonlu (PMD) ve keratokonuslu (KC) gözlerdeki topografi paternlerini ve değişkenlerini karşılaştırmayı amaçlamaktadır.

GEREÇ VE YÖNTEM: Bu çalışma retrospektif, karşılaştırmalı olgu serisidir. PMD'li 15 hastanın 29 gözü ve KC'li 25 hastanın 46 gözü incelendi. Scheimpflug kamera ile elde edilen aksiyel eğrilik haritaları, anterior ve posterior elevasyon haritaları, ve pakimetri haritalarının topografik paternleri sınıflandırıldı.

BULGULAR: PMD'li gözlerdeki (tüm aksiyel eğrilik harita paternin %93.1'i) yengeç-kıskacı paterni en yaygın olanıydı. Keratokonuslu gözlerde en sık paternler inferior dikleşme (%41.3) ve santral dikleşme (%39.1) idi. PMD'li gözlerde elevasyon haritalarındaki en sık patern asimetrik ada (%96.6) paterniydi. KC'li gözlerde ise, en sık elevasyon haritası paterni asimetrik inkomplet yükselti (%54.3) paterniydi ve bunu santral ada (%17.4) paterni ve asimetrik düzenli yükselti (%15.2) paterni takip ediyordu. PMD'li gözlerdeki en sık pakimetrik patern merkezden uzak oval (%51.7) paterndi. KC'li gözlerde, parasantral oval (%54.3) patern en sık idi ve bunu merkezden uzak yuvarlak (%34.8) patern izliyordu. İşlem karakteristik (İK) grafikleri PMD ve KC ayırdetmede anterior ve posterior asferisite (Q) değerlerinin İK eğrisi altındaki en fazla alana (sırasıyla 0.98 ve 0.93) sahip olduklarını gösterdi.

SONUÇ: PMD'li gözlerde aksiyel eğrilik haritalarında yengeç-kıskacı paterni; anterior ve posterior elevasyon haritalarında asimetrik ada paterni; ve pakimetri haritalarında merkezden uzak oval patern sık olarak gözlendi. PMD'yi KC'den etkin bir şekilde ayırdetmede korneanın Q değerleri klinik olarak uygun değişkenler olabilir.

ANAHTAR KELİMELER: Kornea hastalıkları, Keratokonus, Kornea topografisi.

ABSTRACT

OBJECTIVE: This study aims to compare the topography patterns and parameters in eyes with pellucid marginal degeneration (PMD) and eyes with keratoconus (KC).

MATERIAL AND METHODS: This study is a retrospective and comparative study. Twenty-nine eyes of 15 patients with PMD and 46 eyes of 25 patients with keratoconus (KC) underwent examination. Topographic patterns of axial curvature, anterior and posterior elevation maps, and pachymetric maps obtained by the Scheimpflug camera were categorized.

RESULTS: In eyes with PMD, the crab-claw pattern (93.1% of all axial curvature map patterns) was the most prevalent. The most common patterns in eyes with KC were inferior (41.3%) and central (39.1%) steepening patterns. In eyes with PMD, the asymmetric island pattern (96.6%) was the most prevalent pattern in elevation maps. Asymmetric incomplete ridge pattern (54.3%), center island (17.4%), and asymmetric regular ridge pattern (15.2%) were the most common elevation map patterns in eyes with KC. Among pachymetric map patterns, the decentred oval pattern was most frequent in eyes with PMD, paracentral oval pattern (54.3%), and decentred round pattern (34.8%) in eyes with KC. The result of the receiver operating characteristics (ROC) graphs showed that the anterior and posterior asphericity (Q) values had the maximum area under the ROC curve (0.98 and 0.93 respectively) in discriminating PMD and KC.

CONCLUSIONS: The crab-claw pattern for the axial curvature map, asymmetric island pattern for the anterior and posterior elevation map, and decentred oval pattern for the pachymetric map were frequently observed in eyes with PMD. Asphericity values of the cornea may be clinically relevant parameters for effectively discriminating PMD from KC.

KEYWORDS: Corneal diseases, Keratoconus, Corneal topography.

Geliş Tarihi / Received: 12.09.2022
Kabul Tarihi / Accepted: 09.12.2022

Yazışma Adresi / Correspondence: Dr. Öğr. Üyesi Ayşe Güzin TAŞLIPINAR UZEL
Ufuk Üniversitesi Tıp Fakültesi, Göz Hastalıkları Ana Bilim Dalı
E-mail: agtaslipinar@gmail.com
Orcid No (Sırasıyla): 0000-0002-0079-5179, 0000-0002-9624-440X, 0000-0003-2563-1792

Etik Kurul / Ethical Committee: Ufuk Üniversitesi Etik Kurulu (23.03.2018/7).

INTRODUCTION

An ectatic disorder of the peripheral cornea, pellucid marginal degeneration (PMD), is characterized by a narrow band of thinning extending from the 4 to the 8 o'clock positions (1- 3). Because PMD and keratoconus (KC) have similar clinical presentations, it is difficult to accurately assess the prevalence of PMD (4).

Although PMD and KC share many clinical characteristics, there are some distinctions in the age at which the diseases first manifest (5). It was reported that PMD was classically diagnosed between the second and fifth decades of life (6). Against the rule astigmatism is frequently seen in PMD due to flattening along the vertical meridian. The inferior peripheral steepening that extends into the mid-peripheral inferior oblique corneal meridians gives its distinctive crab-claw pattern in the corneal topography. However, it was found that this pattern was also seen in the eyes with KC (7). It can be challenging to distinguish between KC and PMD, especially in the early stages. Differentiation of PMD from KC is important because of incorrect diagnosis which could lead to inappropriate management. There are currently no specific topographic criteria for the diagnosis of PMD.

In order to distinguish between PMD and KC, this study aimed to identify topographic patterns and compare the quantitative parameters of PMD and KC obtained by the Scheimpflug camera.

MATERIALS AND METHODS

The medical records of 15 patients with PMD (29 eyes) and 25 patients with KC (46 eyes) were reviewed. Informed consent was obtained from all participants in the study. In slit lamp examination, band-like inferior corneal thinning and protrusion above this area, absence of Fleischer ring, Vogt's striae, and vascularization were evaluated as PMD. The KC group was clinically diagnosed with a conical protrusion, Vogt's striae, and Fleischer ring. Subclinical PMD and KC patients who were contact lens wearers were excluded. For all eyes, topographic and tomographic measurements were obtained by Scheimpflug camera (Pentacam; Oculus GmbH, Wetzlar, Germany). The most frequent patterns of four refractive maps (axial curvature, anterior and posterior elevation, and corneal thickness map) were determined. For the axial power map, a 1.5 Diopter (Dpt) color bar was used. The American color-coded bar was used for anterior and posterior elevation maps and corneal thickness maps. The pachymetry map was fixed to 300-900 micrometers in 10-micrometer steps. Best-fit sphere (BFS) program was used for elevation maps. The anterior elevation map was displayed in 5 μm steps, the posterior elevation map was displayed in 10 μm steps, and the corneal thickness map was displayed in 10 μm steps. Definitions of axial, elevation, and pachymetry maps were adapted from a study by Fuchihato et al. (8). These classifications were performed by one ophthalmologist (YA). The mean value of apex pachymetry (AP), the thinnest corneal thickness (TCT), the difference between AP and TCT, Kmax, anterior asphericity (Q), anterior K1, anterior K2, anterior astigmatism, posterior Q, posterior K1, posterior K2, posterior astigmatism were recorded. These values were compared between patients with PMD and patients with KC.

Ethical Committee

The Declaration of Helsinki was followed in the conduct of this retrospective and cross-sectional study. The institutional research committee's ethical guidelines were followed in all of the study's methods. (Institutional Review Board (IRB) approval is provided by Ufuk University with the project number 23.03.2018/7).

Statistical Analysis

Statistical analyses were performed by using Statistical Package for Social Sciences (SPSS) for Windows 15.0. Descriptive statistics were given as mean, standard deviation, frequency, and percentage. We used a t-test to evaluate continuous data and Chi-square (X2) test for categorical data. P values less than 0.05 were regarded as statistically significant. The receiver operating characteristics (ROC) curves are formed for some asphericity parameters, and threshold values were determined to discriminate KC from PMD.

RESULTS

The current study included 29 eyes of 15 patients with PMD, and 46 eyes of 25 patients with KC. The mean age was 49.68±13.41 years in the PMD group and 30.28±9.65 years in the KC group ($p<0.001$). The female-to-male ratio was 30/16 in the KC group and 12/17 in the PMD group, and the difference was not statistically significant ($p= 0.057$). The crab-claw pattern was the most common pattern of axial power map in PMD patients (93.1%). In keratoconus patients, inferior steepening (41.3%) and central steepening patterns were almost equal in frequency **(Figure 1, 2)**.

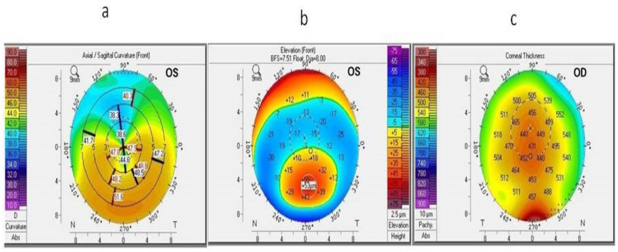

Figure 1: The most frequent topographic map patterns of pellucid marginal degeneration **a.** Crab-claw pattern **b.** Asymmetric island pattern **c.** Decentrated oval pattern

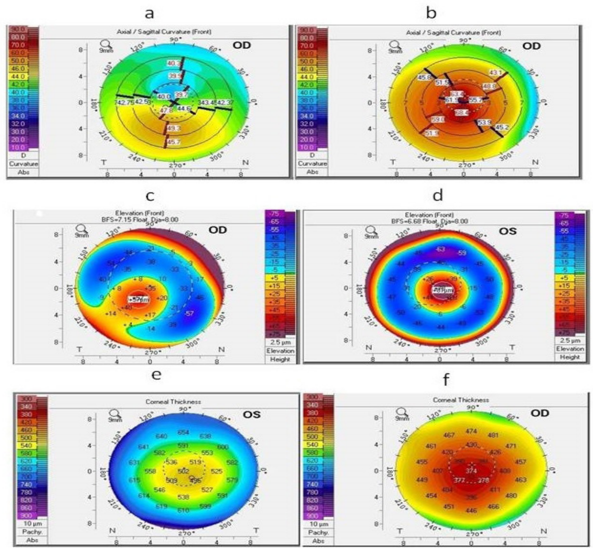

Figure 2: The most frequent topographic map patterns of keratoconus. **a.** Inferior steepening pattern **b.** Central steepening pattern **c.** Asymmetric incomplete ridge pattern **d.** Central island pattern **e.** Paracentral oval pattern **f.** Decentrated round pattern

Each group demonstrated similarities for the anterior and posterior surfaces in elevation maps. The most frequent pattern was an asymmetric island (96.6%) in the PMD group and an asymmetric incomplete ridge pattern (54.3%), central island (17.4%), and asymmetric regular ridge pattern (15.2%) in the KC group. The decentralized oval pattern was the most common pachymetric map pattern (51.7%) in eyes with PMD. The paracentral oval pattern (54.3%) and decentred round pattern (34.8%) were the two most prevalent patterns in eyes with KC (Figures 1, 2).

Shows the results of topographic analyses and intergroup comparisons **(Table 1)**.

Table 1: Kmax: maximum curvature power of the front corneal surface; Q value: asphericity in the central 30^0 of cornea.

Corneal parameters	PMD group	KC group	P
Apex pachymetry	473.58±53.64	449.41±43.35	0.035*
Kmax	56.01±8.33	57.27±8.01	0.51
Thinnest corneal thickness (TCT)	453.20±62.72	434.04±55.70	0.17
Difference between apex and TCT	21.13±21.42	15.43±17.46	0.21
Anterior Q	0.46±1.03	-1.0±0.53	0.0001*
Anterior K1	39.93±5.79	47.59±4.86	0.0001*
Anterior K2	50.46±3.29	51.61±6.10	0.35
Anterior astigmatism	10.51±6.96	4.17±1.89	0.0001*
Posterior Q	0.98±2.80	-0.96±0.58	0.0001*
Posterior K1	-5.42±1.08	-6.94±0.89	0.0001*
Posterior K2	-7.29±0.55	-7.85±1.01	0.009*
Posterior astigmatism	1.86±1.36	0.91±0.45	0.0001*

In the PMD group, apex pachymetry values were significantly thicker than in the KC group ($p=0.035$). The mean values of the thinnest corneal thickness (TCT) and the difference between apex thickness and TCT in the PMD group were similar to those in the KC group. The mean values of anterior Q, anterior K 1, anterior astigmatism, posterior Q, posterior K1, posterior K2 and posterior astigmatism were statistically different between groups ($p<0.001$ for all). A ratio of against the rule of astigmatism was 93% in the PMD group. In the KC group, 58.3% of astigmatism was around the 30˚ horizontal axis.

The result of ROC graphs showed that the anterior and posterior Q values had the maximal area under the ROC curve (0.98 and 0.93 respectively) in discriminating PMD and KC. The anterior Q value showed 100% sensitivity and 84.8% specificity with a cutoff value of – 0.46. The posterior Q value showed 100% sensitivity and 80.0% specificity with a cutoff value of -0.54 **(Figure 3)**.

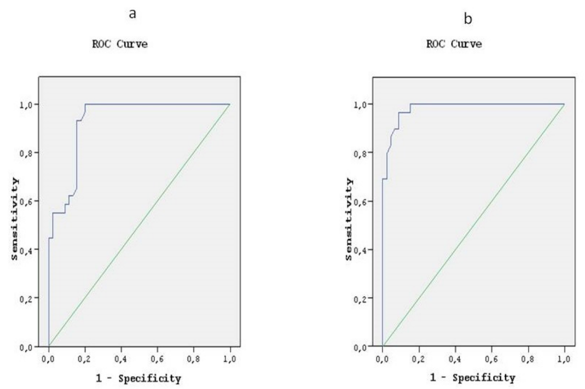

Figure 3: The Receiver Operating Characteristic (ROC) curves of Asphericity value (Q); **a.** Anterior Q **b.** Posterior Q

DISCUSSION

In the present study, crab claw patterns for the axial curvature map, asymmetric island patterns for the anterior and posterior elevation map, and decentred oval patterns for the pachymetric map were frequently observed in the PMD group. Asphericity values of the cornea were found to be significant parameters in differentiating PMD from KC. Differentiation of PMD from KC may be difficult, especially in eyes with similar clinical findings and atypical topographic findings. Although the crab-claw pattern is the typical axial power map pattern for PMD patients, this pattern is also detected in eyes with inferior KC and pellucid-like keratoconus (1, 2, 9). Because both the prognosis and management of PMD and KC are different; analyzing only the anterior corneal surface is not sufficient in the differential diagnosis of PMD. To date, there are a few studies on the pattern of elevation and pachymetric maps in eyes with PMD (8,10,11). Therefore, it is important to describe the specific patterns for KC and PMD and combine them other topographic measurements.

Based on our study in the PMD group; the crab-claw pattern was the most frequent pattern in the axial curvature map (93.1%). In the KC group; inferior steepening (41.3%) and central steepening (39.1%) were almost equal in frequency. These results were similar to a study in the Japanese population (8). Asymmetric island pattern (96.5%) in elevation maps of anterior or posterior surfaces was characteristic of PMD. An asymmetric incomplete ridge pattern was detected in both PMD and KC but the incidence in PMD was very low (3.4%). In the KC group, asymmetric incomplete ridge pattern (54.3%), central island pattern (17.4%), and asymmetric regular ridge pattern (15.2%) were common patterns.

For pachymetric maps, a decentred oval pattern (51.7%) was seen only in eyes with PMD. Paracentral oval (24.1% in PMD, 54.3% in KC), and decentrated round (20.7% in PMD, 34.8% in KC) patterns were seen in both PMD and KC with lower incidence in PMD eyes. In a study in the Japanese population, decentred round and decentrated oval patterns were seen only in eyes with PMD (8). There was a difference in corneal astigmatism between groups; due to the flattening of the vertical meridian, marked against the rule astigmatism was seen in PMD patients (93%). AP values were significantly higher in the PMD group (p=0,035). Although statistically insignificant, the mean thinnest corneal thickness value and the difference between AP and TCT were higher in the PMD group. These results were similar to Tummanapalli's results (11).

In the present study, no statistically significant difference was found in maximum keratometry data (Kmax) between the groups. Fuchihata et al. reported a greater Kmax in eyes with KC than PMD (Kmax:63.0±10.9 D keratoconus vs. 52.1±5.70 D in PMD eyes) (8). However, Koçluk et al. (Kmax:49.7 D keratoconus vs. 54.6D PMD) and Koç et al. (50.4±3.2 D keratoconus vs 51.1±3.2 PMD) did not find significant differences between PMD and KC (9, 11).

Corneal Q is a descriptor of corneal shape and refers to the rate of change in curvature from the center of the cornea to the periphery. (13-15) The positive Q in eyes with PMD represents the oblate shape of the cornea. In our study in the PMD group the anterior and posterior Q values were significantly higher than in the KC group. The mean Q values were positive in the PMD group and negative in the KC group.

The result of ROC graphs of topographic parameters showed that the anterior and posterior Q values had the highest area under the ROC curve (0.98 and 0.93 respectively) in discriminating PMD and KC. The anterior Q value showed 100% sensitivity and 84.8% specificity with a cut-off value of - 0.46. The posterior Q value showed 100% sensitivity and 80.0% specificity with a cut-off value of - 0.54. Tummanapalli et al. reported that the anterior Q value which was recorded by an Orbscan IIz scanning-slit topographer had the highest area under the ROC curve (AUC=0.974) in discriminating between PMD and KC (sensitivity 93.3%, specificity 90.6% and cut-off value > -0.07) (11). Koçluk et al. found mean Q of -0.54 in keratoconus and 0.09 in the PMD group (p<0.0001) (12). But they did not evaluate these values with the ROC curve. However, Koç et al. did not find significant differences in asphericity data between these two ectasias (Q=-0.04 ±0.37 inferior keratoconus vs -0.05±0.36 PMD, p=0.95) (9).

There are some limitations of our study. This was a retrospective case-series study and because of the rarity of PMD, the number of patients with PMD was small. In addition, we were able to examine the corneal maps for 8 mm diameter zones. Belin et al. , suggested that eyes with PMD should analyze the pachymetric map covering the central 12 mm of the cornea (10). But Fuchihata et al. examined the corneal maps for central 12 mm diameter zones and found that most of the data outside the 9 mm diameter zone were extrapolated (8).

The results of our study showed that the crab-claw pattern (93.1%) for the axial curvature map, asymmetric island pattern for anterior and posterior elevation maps (96%), and decentred oval pattern (51%) for the pachymetric map were frequently observed in eyes with PMD. Asphericity values of the cornea may be clinically relevant parameters for effectively discriminating PMD from KC. There are KC indices in many current corneal topography devices (16). PMD indices may be developed with the use of these patterns and parameters. Further studies with larger groups might be required to verify these findings.

REFERENCES

1. Jinabhai A, Radhakrishnan H, O'Donnell C. Pellucid corneal marginal degeneration: A review. Contact Lens&Anterior Eye. 2011;34:56-63.

2. Martínez-Abad A, Piñero DP. Pellucid marginal degeneration: Detection, discrimination from other corneal ectatic disorders and progression. Cont Lens Anterior Eye. 2019;42(4):341-349.

3. Singar E. Kornea ektazisine yaklaşım ve tedavi. Turkiye Klinikleri J Ophthalmol. 2021; 30 (1): 55-74.

4. Baykara M, Doğru M, Özmen A, Özçetin H. Pellusid marjinal dejenerasyonda klinik ve diagnostik özellikler: 2 olgu sunumu. MN Oftalmoloji. 2002; 9:371-373.

5. Rabinowitz YS. Keratoconus. Surv Ophthalmol. 1998;42:297-319.

6. Krachmer JH, Feder RS, Belin MW. Keratoconus and related non inflamatory corneal thinning disorders. Surv Ophthalmol. 1984;28:293-322.

7. Lee BW, Jurkunas UV, Dagher MH et al. Ectatic disorders associated with a claw-shaped pattern on corneal topography. Am J Ophthalmol. 2007;144:154-156.

8. Fuchihata M, Maeda N, Toda R et al. Characteristics of corneal topographic and pacymetric patterns in patients with pellucid marginal corneal degeneration. Jpn J Ophthalmol 2014;58:131-138.

9. Koç M, Tekin K, İnanç M, et al. Crab claw pattern on corneal topography: pellucid marginal degeneration or inferior keratoconus? Eye. 2017;32(1):1-8.

10. Belin MW, Asoto IM, Ambrosıo R, et al. What's in a Name: Keratoconus, Pellucid Marginal Degeneration, and Related Thinning Disorders Am J Ophthalmol. 2011;152:157-162.

11. Tummanapalli SS, Maseedupally V, Mandathara P, Rathi VM, Sangwan S. Evaluation of corneal elevation and thickness indices in pellucid marginal degeneration and keratoconus. J Cataract Refract Surg. 2013;39:56-65.

12. Koçluk Y, Yalnız-Akkaya Z, Burcu A, Örnek F. Comparison of Scheimpflug Imaging Analysis of Pellucid Mardinal Corneal Degeneration and Keratoconus. Ophthalmic Res. 2015;53:21-27.

13. Calossi A. Corneal asphericity and spherical aberration. J Refract Surg. 2007;23(5):505-514.

14. Torquetti L, Ferrara P. Corneal asphercity changes after implantation of intrastromal corneal ring segments in keratoconus. Emmetropia. 2010;1:178-181.

15. Utine CA, Ayhan Z, Engin CD. Effect of intacorneal ring segment implantation on corneal asphericity. Int J Ophthalmol. 2018;11:1303-1307.

16. Belin MW, Ambrosio R. Scheimpflug imaging for keratoconus and ectatic disease. Indian J Ophthalmol. 2018;61:401-406.