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Pentacam Significant Topographical Characteristics and Indices in Keratoconus

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Abstract: Background: The pentacam system is a relatively new diagnostic imaging tool. It is a special imaging system that seems to be able to reliably measure both the anterior and posterior corneal surfaces, both pre- and post-operatively, using a rotating Scheimpflug camera. The pentacam helps the ophthalmologist to better quantify normal postoperative cornea and better diagnose ectatic disorders. **Aim:** To study the common topographical characteristics of Scheimpflug system (Oculus Pentacam) of patients with a confirmed diagnosis of keratoconus in private centers at Tanta city. **Patients and Methods:** This comparative, retrospective research was conducted in 100 eyes of 50 patients with keratoconus (32 male, 18 female with were included in this study. The mean age was 26.07±4.98 years. The Control Group included hundred eyes of 50 individuals with average normal corneal parameter (non keratoconic) (30 male, 20 female). **Results:** It has been concluded, the interpretation and investigation of the show is intuitive: if the progression of the corneal thickness indicates an average index greater than 1.1, the rise in the progression of the thickness is clinically relevant and the red curve is not parallel to the black broken lines but steeper. It is also clinically relevant if a red center is seen in the difference map between the BFS and the improved BFS elevation map. **Conclusion:** The aim of our study is to help the refractive surgeon identify patients who may be at risk of post-surgical ectasia and/or to help identify early or subclinical keratoconus.
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Key words: Pentacam, topography, Keratoconus, scheimpflug

1. Introduction

For years, keratometry, conventional slit-lamp, ultrasound pachymetry and placid disc-based topography systems have been effective tools for clinicians and researchers to assess and diagnose the anterior segment of the eye. However, each of these modalities has performance constraints and, as a result of recent developments in the field of ocular surgery, new information requirements have emerged **(Dick et al., 2005).**

The Pentacam system is a relatively new diagnostic imaging tool that in a two- second, noncontact exam provides a comprehensive, three-dimensional scan of the anterior chamber **(Neuhann et al., 2007).**

The pentacam is the first instrument to take several images of the anterior segment using a rotating Scheimpflug camera and use them to produce three-dimensional images and calculate eye measurements **(Belin, 2009).**

Corneal disorders (Including keratoconus and ectasia after Laser In-Situ Keratomilieusis (LASIK)) are the second most popular cause for keratoplasty in the United States, accounting for 15 % of corneal transplants. The occurrence of keratoconus is essential, based on epidemiological studies, to be almost 1 in 2000 in the general public **(Woollensak, 2011).**

For the effectiveness of refractive surgery, careful preoperative screening is important. Screening patients for corneal anomalies that would raise the risk of postoperative corneal ectasia if the patient was operated on is crucial. For example, it is known that patients with keratoconus or pellucid marginal degeneration have bad postoperative results that typically advance to ectasia (**Ambrosio, 2009).**

The rotating Scheimpflug system's high reliability is due to the measurement principle in which highly accurate measurements are obtained by a large number of repeated often central, corneal measurements. The topographical analysis is based on the actual measurement of the elevation from limbus to limbus of both the front and back corneal surfaces (**Lackner, 2006).**

The Belin/Ambrósio Enhanced Ectasia Display is the first comprehensive refractive surgical screening instrument that is fully dependent on elevation. The software aims to help the refractive surgeon in recognizing such patients at risk of postoperative

ectasia and/or in identifying early or subclinical keratoconus **(Belin, 2009).**

It is hoped to have increased sensitivity without the false positive rates usually correlated with curvature-based programs by using information from both the anterior and posterior corneal surfaces as well as complete pachymetric data **(Belin, 2009).**

Aim of the Work

The aim of the current research is to study the common topographical characteristics of Scheimpflug system (Oculus Pentacam) of patients with a confirmed diagnosis of keratoconus in private centers at Tanta city.

2. Patients and Methods

Methodology:

This retrospective, comparative, study involved patients with a confirmed diagnosis of keratoconus in private centers at Tanta city.

All participants underwent a complete ophthalmological examination including corrected distant visual acuty (CDVA) measurement (Snellen charts), slit-lamp biomicroscopy, applanation tonometry, dilated retinoscopy and indirect fundus examination (with non-contact + 90 diopters [D] lens), and the Scheimpflug system anterior segment tomography (Oculus Pentacam), the data will be collected from files of patients examined between 2014 to 2018 (total 100 keratoconic eyes) and (100 normal eyes).

Inclusion criteria:

1- Patients with a confirmed diagnosis of primary keratoconus, they were seeking for usual examination or refractive surgery.

2- Keratoconus diagnosis was confirmed using clinical findings as stromal thinning, iron deposits within the corneal epithelium (Fleischer's ring), vertical stress lines in the deep stroma, (Vogt's striae), anterior stromal scars, Munson's sign, scissoring reflex and oil droplet sign on retinoscopy.

All patients included in the study underwent the following:

A-Full history taking including: personal history including: Name, age, sex, occupation, address, etc, history of diabetes mellitus: Age at onset, duration and medication. And history of previous ocular diseases or surgeries or trauma.

B-Full ophthalmic examination focusing on visual acuity assessment, including uncorrected (UDVA) and corrected distant visual acuity (CDVA), manifest and cycloplegic refraction, slit lamp examination, dilated fundus examination and assessment of IOP by applanation & air puff tonometry.

C-Corneal Tomography:

Corneal tomography using pentacam scheimpflug system.

C-Corneal Tomography: Corneal tomography using pentacam scheimpflug system.

D- Technique

The Scheimpflug ocular imaging system (Oculus Pentacam, Oculus Optikgerate GmbH, Wetzlar, Germany) has been used for tomography of the anterior segment (corneal topography and pachymetry). Using a split light source and a 360◦ revolving camera, this device captures up to 50 sectional images of anterior segment structures in around two seconds. The Scheimpflug imaging under scotopic conditions with undilated pupils (SV) was conducted by a single experienced technician.

In automatic mode, images were captured and a single test was utilized for statistical analysis with a quality score (QS) of over 95 %.

Maps were obtained for sagittal curvature, corneal thickness, anterior and posterior altitude.

The mean K (front), topographic astigmatism, pupil-center pachymetry, apical pachymetry, thinnest pachymetry (TP), corneal volume and maximum K (Kmax) values, pachymetric evaluation (PTI, CTSP) and topometric indices (ISV, IVA, KI, CKI, IHA, IHD).

Statistical analysis:

The reported data was analyzed using version 20.0 of the statistical package for social sciences, (SPSS Inc., Chicago, Illinois, USA).

The mean± standard deviation (SD) was represented as quantitative data. The frequency and percentage were represented as qualitative data.

The following tests were carried out:

When comparing two means, independent samples t-test of significance were used. To compare proportions between qualitative parameters, the Chi-square (2) significance test was used. The confidence interval was set to 95% and the accepted error margin was set at 5%. The p-value was therefore deemed to be significant: probability (P-value); P-value < 0.05 was deemed to be significant.

3. Results

No statistically significant differences in age & sex were found in both groups.

Table (1): Comparison between study and control groups based on demographic data.

Parameters	Keratoconus Group (n=50)	Control group (n=50)	t/x2#	p-value
Age (years)	26.07±4.98	26.85±5.49	0.661	0.314
Sex				
Male	32 (64%)	30 (60%)	1.945#	0.295
Female	18 (36%)	20 (40%)		

Using: t-Independent Sample t-test; #x^2:
Chi square test p-value>0.05 NS

No statistically significant difference among groups according to age and sex is shown in this table.

Table (2): The mean UCVA, BCVA, and cylindrical error in group A (keratoconus).

Parameters	Mean ± SD
UCVA	0.26±0.10
BCVA	0.49±0.20
Sphere	-2.96±1.85
Cylinder	-4.13±2.03

This table shows that the mean of UCVA 0.26±0.10, BCVA 0.49±0.20, Sphere -2.96±1.85 and Cylinder -4.13±2.03.

Table (3): Comparison between Keratoconus Group and Control group according to Corneal Parameters by pentacam.

Variables	Keratoconus Group (n=100) Mean± SD	Control group (n=100) Mean ± SD	t-test	p-value
K1 (D)	49.47±6.43	43.76±0.98	9.424	<0.001*
k2 (D)	53.35±7.18	44.57±0.99	5.400	<0.001*
Km (D)	51.31±6.63	44.17±0.92	4.968	<0.001*
Rm_mm	6.83±0.71	7.85±0.16	3.944	<0.001*
R_min_mm	6.14±0.82	7.75±0.17	3.766	<0.001*
ISV	78.13±31.77	18.16±3.47	3.152	<0.001*
IVA	0.79±0.41	0.14±0.03	3.042	<0.001*
KI	1.24±0.15	0.95±0.30	2.962	<0.001*
CKI	1.09±0.05	1.03±0.01	5.900	<0.001*
IHA	16.22±13.76	4.28±3.88	5.800	<0.001*
IHD	0.061±0.408	0.008±0.004	2.784	<0.001*
Pachymetry	494.60±51.41	559.47±29.38	6.760	<0.001*
Thinnest location (µm)	462.88±67.33	555.19±28.65	2.756	<0.001*
Anterior elevation (µm)	14.28±6.12	5.10±3.06	6.592	<0.001*
Posterior elevation (µm)	28.56±5.10	11.22±4.08	2.576	<0.001*
Cylinder	-4.13±2.03	-1.07±0.92	7.562	<0.001*
CTSP	1.93±2.06	.22±1.01	4.607	<0.001*
PTI	1.02±2.78	1.07±0.032	4.009	<0.001*

Using: Independent Sample t-test; *p-value <0.001 HS

This table demonstrates statistically significant differences among groups according to K1 (D), k2 (D), Km (D), Rm_mm, R_min_mm, ISV, IVA, KI, CKl, IHA, IHD, Pachymetry, Thinnest location (µm), Anterior elevation (µm), Posterior elevation (µm) and Cylinder, with p-value <0.001 HS.

Our study showed abnormal shapes in anterior sagittal maps, anterior elevation maps, posterior elevation maps, pachymetry maps in keratoconic eyes group.

In the present study, the most common shape of anterior sagittal maps in keratoconic eyes group was AB/IS [32%] and the mean value of anterior sagittal maps was -11.1–9.6 [- 1.04± 3.48]

Table (4): Ant. sagittal map shapes of the keratoconus group.

Ant. Sagittal Map	Total (n=100)
Shape	
AB/IS	32 (32%)
Irregular	20 (20%)
SB	16 (16%)
AB/SRAX	14 (14%)
AB/SS	6 (6%)
Round	6 (6%)
AS/SS	4 (4%)
SB/SRAX	2 (2%)
Value	
Range [Mean±SD]	-11.1–9.6 [-1.04±3.48]

In the present study, the most common shape of anterior elevation maps in keratoconic eyes group was irregular [50%] and the mean value of anterior elevation maps was -3–34 [5.88±7.26].

Table (5): Ant. elevation map shapes of the keratoconus group.

Ant. Elevation Map	Total (n=100)
Shape	
Irregular	50 (50%)
Tongue like extention	38 (38%)
Symmetric hourglass	8 (8%)
Isolated island	4 (4%)
Value	
Range [Mean±SD]	-3–34 [5.88±7.26]

In the present study, the most common shape of posterior elevation maps in keratoconic eyes group was irregular [64%] and the mean value of posterior elevation maps was -6–74 [13.26±16.12]

Table (6): Post. elevation map shapes of the keratoconus group.

Post elevation map	Total (n=100)
Shape	
Irregular	64 (64%)
Tongue like extention	24 (24%)
Isolated island	6 (6%)
Symmetric hourglass	6 (6%)
Value	
Range [Mean±SD]	6–74 [13.26±16.12]

In the present study, the most common shape of pachymetry maps in keratoconic eyes group was concentric [72%] and the mean value of pachymetry maps was 28–95 [28.47±25.49].

Table (7): Pachymetry map shapes of the keratoconus group.

Pachymetry map	Total (n=100)
Shape	
Concentric	72 (72%)
Dome shape	22 (22%)
Keratoglobus	6 (6%)
Value	
Range [Mean±SD]	28–95 [28.47±25.49]

In the present study, the most common shape of corneal thickness profile in keratoconic eyes group was normal [52%] and the mean value of corneal thickness profile maps was 0.52–2.87 [1.26±0.42]

Table (8): Corneal thickness profile shapes of the keratoconus group.

Corneal Thickness Profile	Total (n=100)
Shape	
Normal	52 (52%)
Quick Slope	44 (44%)
S-shape	4 (4%)
Value	
Range [Mean±SD]	0.52–2.87 [1.26±0.42]

4. Discussion

Exclusion of keratoconus is essential for individuals asking for refractive surgery. Diagnosis of subclinical keratoconus and keratoconus was found to be much more than in normal individuals. **(Zhou L et al., 1996)**

For many years, preoperative Placido disc-based video keratography were the only available applications used to recognize individuals at risk of keratoconus suspects, together with intraoperative and preoperative pachymetry to avoid risky corneal thinning **(Binder et al., 2005).**

The pentacam is an advanced application which uses rotating Scheimpflug camera to obtain images for anterior and posterior surfaces of the cornea. The Pentacam rotating Scheimpflug camera also calculate posterior elevation and corneal thickness which is known to be highly repeatable and reproducible **(De sanetis et al., 2008)**.

Pentacam measurements for the elevation data show and record values of both the anterior and the posterior corneal surface. **(Farm HB and Lim KL, 2006)**.

The epithelium of the anterior corneal surface is considered one epithelial cell layer of 6-8µthinner over the nipple of the cone which highlights the more superiority of the posterior elevation map than the anterior elevation map. For keratoconus screening, normal values for the posterior elevation were estimated to be nearly 5 11µ higher than those for the anterior elevation **(Cairns G and McGhee CN, 2005).**

Belin MW, and Khachikian SS (2009) postulated that Diagnosis of keratoconus is made if the elevation at the thinnest location off the standard BFS was greater than 15µfor the corneal front surface or greater than 20µ for corneal back surface. The earliest sign of subclinical keratoconus may be the rise in posterior elevation **(Rao et al., 2002)**.

The present study evaluated corneal parameters in both normal and keratoconic eyes by using the pentacam. The mean cylindrical errors, recorded by pentacam, were significantly higher among group A (-4.13 ± 2.03D) than control group B (-1.07±0.92D) with statistically significant difference (p=0.001). The mean values of K1, K2, KM, ISV, IVA, kI CKI, and anterior and posterior elevation increased among keratoconus group relative to control group with statistically significant differences (p<0.001). The median levels of IHA and IHD were higher in keratoconus group relative to control group (p<0.001).

In the present study, all corneal parameters were found with high diagnostic accuracy as measured by pentacam with the highest accuracy recorded for ISV followed by IHD, K2, km, IVA and K1. The least in accuracy was IHA.

Our study showed higher mean anterior elevation among cases with keratoconus group A (14.28 ± 6.12µm) compared to control group B (5.10 ± 3.06µm) and statistically, the difference was highly significant (P< 0.001). The study also showed higher mean posterior elevation among cases with keratoconus group A (+28.56 ± 5.10 µm) compared to control group B (+11.22 ± 4.08 µm) and statistically, the difference was highly significant (P< 0.001). The values of R mm, R min mm, pachymetry, and thinnest

location were less in keratoconus (Group A) compared to control (Group B) with statistically significant difference (p<0.001).

Belin and Khachikian (2009) where they found that; there was a higher mean anterior elevation among cases with keratoconus (20.9±21.9 µm) relative to control group (1.63±1.4 µm) and the difference was statistically highly significant (P< 0.001). **Mihaltz et al, 2010** found that there was a higher mean anterior elevation among cases with keratoconus (33.3 ± 28.6 µm) compared to control group (2.7 ± 2.3 µm) and the difference was statistically highly significant (P< 0.001). **Hashemi and Mehravaran 2010** reported that for the anterior surface elevation, central readings values greater than' 15 µm could be indicative of keratoconus.

Mean posterior corneal elevation in normal corneas using Orbscan II has been recorded to range from 28 to 30.47 µm by other authors. **Schlegel et al., 2008**. showed maximum central posterior elevation values to be 28.8 µm in keratoconus-suspect eyes and 20.6 µm in normal eyes while the values were 26 µm in normal eyes and 46 µm in keratoconus-suspect eyes in another study by **Lim et al., 2007 Quisling et al., 2006.** reported that mean posterior corneal elevation was 48.50 µm in 36 eyes with clinical keratoconus employing the Orbscan II. These discrepancies may be due to differences in patient characteristics.

Ucakhan et al., 2011 studied different pentacam parameters in, normal eyes, subclinical keratoconus, and keratoconus. They reported that the Scheimpflug system could distinguish between normal and ectatic eyes.

Corneal thinning is a key pathological characteristic of keratoconus; in our study we evaluated the pachymetric data obtained by the pentacam as for the central corneal thinning, in our study we found that there was a lower mean CCT (494.60 ± 51.41 µm) among keratoconus patients compared to control (559.47± 29.38 µm) group and the difference is statistically highly significant (P< 1.000).

In contrast to **Murata et al., 2007** and similar to those reported by **Uçakhan et al., 2008** we found there was no significant difference between hyperopic and myopic CT measurements (P > 0.05). Although the thinnest CT measurements were lower in high myopic eyes, the difference was not statistically significant (P > 0.05).

This was comparable to study by **Mihaltz et al, 2010**. as they found that The mean CCT in keratoconus was (491.3± 43.5 µm), which were highly significantly while CCT in normal persons (555.8 ± 27.9 µm) (p<0.001).

While **Schlegel et al., 2008** show that the mean CCT in keratoconus was (513.5±40.7 µm) and in normal group was (559.7±36.1 µm).

Lim et al. (2007) reported that over a period of 8 years more than one third of subjects with unilateral keratoconus developed manifest keratoconus in the other eye. These authors recorded that, in keratoconus and keratoconus suspects, mean values of maximum posterior elevation and irregularity were substantially higher than in control eyes.

Corneal volume, pachymetry and the association among anterior and posterior corneal form in normal and keratoconus eyes were investigated by **Pinero et al., 2009.** In subclinical and clinical keratoconus, they observed lower pachymetry readings, but observed no remarkable variations between subclinical keratoconus eyes and normal eyes in these measurements.

Based on topographic maps from the pentacam, **Vejarano et al., 2010** reported that in eyes with anterior elevation greater than 15 µm and posterior elevation greater than 20 µm utilizing the best fit toric ellipsoid, keratoconus should be strongly suspected, On the tangential map, the corneal thickness is less than 500 µm, and the keratometric power is greater than 47D, when all are at the same corresponding points. Keratoconus suspects were diagnosed as individuals who had anterior elevation among 12 and 15 µm, posterior elevation among 15 and 20 µm with the corresponding location of the thinnest pachymetry point less than 500 µm.

Conclusion

The purpose of our study is to help the refractive surgeon identify patients who may be at risk of post-surgical ectasia and/or to help identify early or subclinical keratoconus.

From the previous data it is clear that there is no single diagnostic index to diagnose keratoconus, but combination of several data may raise the suspicion to diagnose keratoconus earlier, and help in avoiding postoperative complications.

All corneal parameters were found to have high diagnostic accuracy as measured by pentacam for keratoconus with the highest accuracy recorded for ISV followed by IHD, K2, kmd, IVA and K1. The least in accuracy was IHA.

All corneal parameters measured by pentacam were found to have high diagnostic accuracy with the highest accuracy recorded for R min mm followed by RM mm and thinnest location. The least in accuracy was pachymetry.

References

1. Ambrosio JR. Enhancing Ectasia Screening, November/ December, Cataract & Refractive surgery, 1-3, 2009.
2. Belin M, Khachikian S. Corneal diagnosis and

evaluation, with the OCULUS Pentacam. Highlights of Ophthalmology. 2007.
3. Belin M. Keratoconus/Ectasia Detection with the Oculus Pentacam, Highlights Ophthalmology, volume 35, No. 6 2009.
4. De Sanctis U; Missolungi A; Mutani B; Richardi L; Grignolo F. Reproducibility and Repeatability of Central Corneal Thickness Measurement in Keratoconus Using the Rotating Scheimpflug Camera and Ultrasound Pachymetry, AMERICAN JOURNAL OF Ophthalmology, 144, November, 712-718, 2007.
5. Dick B; Novak J; Neuhann T; Gilg A; Maus M; Naroo S; Holladay J. Interpretation Of Scheimpflug Based Anterior Segment Imaging And Mapping, Eye to Eye, Eurotimes, February, 1-6.2005.
6. Lackner B. Rotating Scheimpflug camera provides accurate corneal thickness measurements. J Cataract Refractive surgery; 34:12-14, 2006.
7. Neuhann T; Belin M; Verges C; Tehrani M; Borasio E; Ambrósio R. XXIV Congress of the ESCRS London, Eurotimes, 1-10. 2007.
8. Piñero DP, Alió JL, Alesón A, et al. Corneal volume, pachymetry, and correlation of anterior and posterior corneal shape in subclinical and different stages of clinical keratoconus. J Cataract Refract Surg.; 36:814–825, 2010.

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