PREVALENCE OF KERATOCONUS IN EGYPTIAN ASTIGMATIC PATIENTS

By

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ABSTRACT

Background: Keratoconus is a corneal ectatic disease characterized by progressive, non-inflammatory corneal disorder, which is characterized by thinning, protrusion of central or paracentral portion of the cornea resulting in irregular astigmatism, myopia, corneal scarring and reduction in visual acuity. The onset of the keratoconus usually occurs at puberty with the progression until the third to fourth decade of the life in most of the cases.

Objective: To estimate the prevalence of keratoconus in Egyptian people who have corneal astigmatism using pentacam as an imaging device.

Patients and Methods: A retrospective study was done at Al-Sayed Galal University Hospital in Ophthalmology outpatient clinics. The retrieved data revealed 80 eyes of 40 patients photographed during the period from June 2019 to December 2019 by using Scheimpflug imaging device (pentacam) as screening device for keratoconus. All such cases underwent a complete ophthalmic examination that includes visual acuity measurement, refraction, slit lamp biomicroscopy, retinoscopy, fundus examination and corneal topography (pentacam).

Results: Mean age of our study cases was 26.55 ± 8 years, which included 22 (55%) males and 18 (45%) females. Cases with KC have higher keratometric corneal values (k1, k2, kmax) and thinner pachymetric values than normal astigmatic eyes.

Conclusion: The higher the astigmatism was the higher risk to have keratoconus. Cases with astigmatism ≥ 1.5D who present to outpatient clinics, should undergo corneal topography screening for early diagnosis of KC even if visual acuity is not affected. Pentacam may provide more accurate information about anterior and posterior corneal anatomy especially in suspected eyes.

Keywords: Keratoconus, Astigmatism, Pentacam.

INTRODUCTION

Astigmatism is a commonly encountered refractive error, accounting for about 13 percent of the refractive errors of the human eye. Keratoconus is bilateral but (usually asymmetrical) corneal disease, characterized by paraxial stromal thinning and weakening that leads to corneal surface distortion. The reported prevalence of keratoconus varies widely depending on geographic location, diagnostic criteria used, and the cohort of the patients selected *(Hashemi et al., 2018)*. Visual disturbance occurs primarily from irregular astigmatism and myopia, and secondary from corneal scarring *(Toprak et al., 2015)*.

Pentacam used to diagnose and detect the progression in patients with keratoconus and also provide detailed information about corneal tomography and topography *(Piñero et al., 2010).*

In the last few years, it has been shown that in healthy individuals, the posterior corneal surface has not only a different amount of astigmatism but also a different alignment of the steep meridian *(Piñero et al., 2012* and *Sugar & Macsai, 2012).*

Assessment of corneal astigmatism at both surfaces play an important role in vision correction procedures, e.g. rigid gas permeable contact lens fit and implantation of a toric intraocular lens (IOL). Studies reported that ignoring posterior corneal astigmatism may significantly affect the estimation of corneal astigmatism. Since manifestations of keratoconus occur at the posterior corneal surface even in early stages of the disease, identifying these changes could help clinicians to detect early stages of keratoconus *(De Sanctis et al., 2011* and *Fares et al., 2012).*

The aim of this study was to determine the prevalence of keratoconus in subjects with astigmatism (-1.5 D) or greater using data from the pentacam scheimpflug tomography.

PATIENTS AND METHODS

A retrospective study was done at Al-Sayed Galal University Hospital in Ophthalmology outpatient clinics. The retrieved data revealed 80 eyes of 40 patients photographed during the period from June 2019 to December 2019 by using Scheimpflug imaging device (pentacam) as screening device for keratoconus.

The study was conducted on patients of middle age group from 18 years old to 40 years old of both sex with keratometric myopic astigmatism ≥1.5D were only included in this study. The number of the selected cases was 80 eyes of 40 patients with myopic astigmatism ≥1.5D bilaterally. Full history was taken including age, past medical history, past ophthalmic history, and if they were complaining of any symptoms other than errors of refraction.

The patients were classified into 2 groups: **Group A** (26 patients, 52 eyes) with myopic astigmatism from -1.5D to -3.0D and **Group B** (14 patients, 28 eyes) with myopic astigmatism more than-3.0D.

Ethical approval and written informed consent:

An approval of the study was obtained from Al- Azhar University academic and ethical committee. Every patient signed an informed written consent for acceptance of the operation.

Exclusion criteria:

- Corneal opacities.

- Patients with uveitis.

- Glucomatous patients.

- History of intraocular foreign body.

- Best corrected visual acuity less than 6\60.

- Patients with retinal detachment.

All the selected cases were diagnosed as astigmatism ≥1.5D from outpatient clinics were investigated by pentacam.

Statistical analysis:

Data collected throughout history, basic clinical examination, laboratory

investigations and outcome measures coded, entered and analyzed using Microsoft Excel software. The data collected were tabulated and analyzed by SPSS (Statistical Package for Social Science) version 25 (Armonk, NY: IBM Corp) on IBM compatible computer. The qualitative data were presented as numbers and percentages and compared between groups using Chi-square test. Also, quantitative data with parametric distribution were presented as means, standard deviations and compared between the two groups using Independent t-test while quantitative data with non-parametric distribution were presented as median, inter-quartile range (IQR) and range and compared between the two groups using Mann-Whitney test. The confidence interval was set to 95% and the margin of error accepted was set to 5%, so the p-value was considered significant at p < 0.05.

RESULTS

Pentacam of a patient in group (A) showing refractive maps of positive keratoconus in the right eye **(Figure 1).**
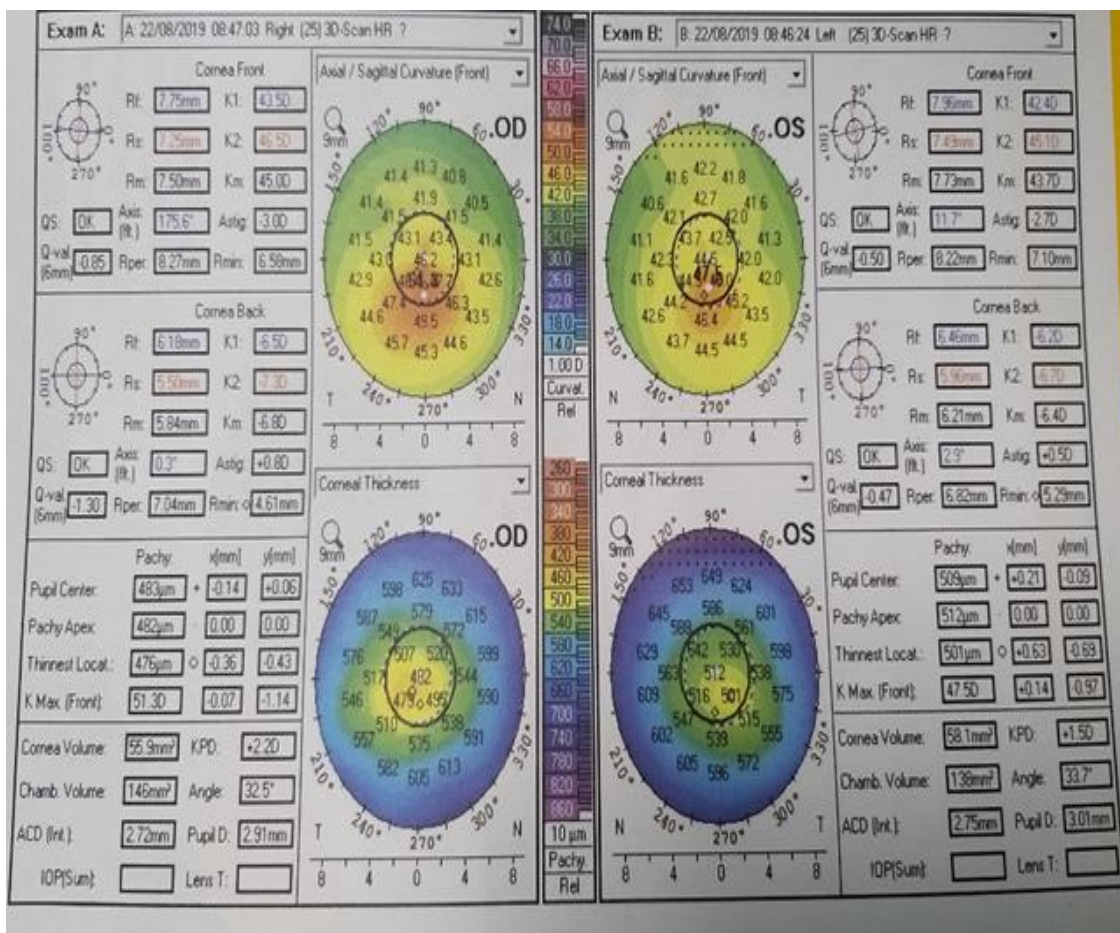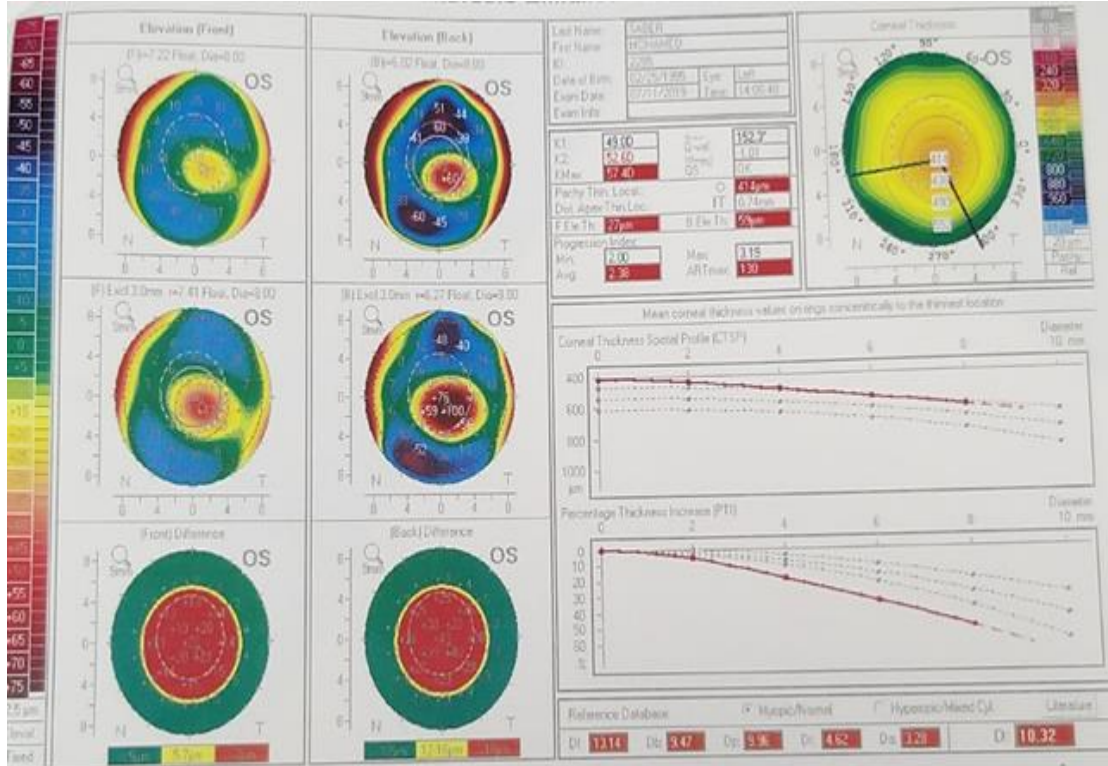

Figure (1): Pentacam of patient in group(A).

Pentacam of a patient in group (B) showing Belin/Ambrósio display of positive keratoconus in the left eye **(Figure 2)**.

Figure (2): **Belin/Ambrósio display of patient in group (B)**

There was no statistically significant difference found between two groups regarding age and gender **(Table 1)**.

Table (1): **Comparison between (Group A & Group B) regarding age and gender of Patients**

Parameters	Groups	Group A No. = 26	Group B No. = 14	P-value
Age	Mean ± SD	25.62 ± 5.25	25.14 ± 4.59	0.779
	Range	18 – 35	18 – 33	
Sex	Female	12 (46.2%)	6 (42.9%)	0.842
	Male	14 (53.8%)	8 (57.1%)	

Independent t-test, Chi-square test

A comparison between group (A) and group (B) is applied as regard all parameters was done and there was highly statistically significant difference. According K readings; K1 was 43.32D in group A vs 46.93D in group B, K2 was 45.44D vs 51.63D, astigmatism was 2.25D vs 4 D, pachy Apex was 518μm vs 482.64 μm, thinnest location was 514.21 μm vs 459.43 μm and kmax was 45.55D vs 52.05D. (K1, flat keratometry; K2, steep keratometry; Kmax, maximum simulated keratometry) **(Table 2)**.

Table (2): Comparison between the different parameters in group (A) and group (B).

Parameters	Groups	Group A No. = 52	Group B No. = 28	P-value
Astigmatism(D)	Median (IQR)	2.25 (1.75 – 2.5)	4 (3.63 – 5.13)	<0.001
	Range	1.5 – 3	3.25 – 8	
K1 (D)	Mean ± SD	43.23 ± 2.73	46.93 ± 6.95	0.001
	Range	38.7 – 55.4	38.9 – 71.3	
K2 (D)	Mean ± SD	45.44 ± 2.85	51.63 ± 7.21	<0.001
	Range	40.2 – 57.9	44 – 75.1	
Pachy Apex (µm)	Mean ± SD	518.00 ± 46.97	482.64 ± 55.70	<0.001
	Range	410 – 604	372 – 587	
Thinnest Location (µm)	Mean ± SD	514.21 ± 47.56	459.43 ± 69.93	<0.001
	Range	405 – 602	310 – 582	
Kmax (D)	Median (IQR)	45.55 (44.2 – 47.0)	52.05 (47.60 – 61.75)	<0.001
	Range	43.1 – 60.5	45.4 – 91.6	

Mann-Whitney test, Independent t-test

A comparison between positive and negative keratoconus in group A is applied as regard all parameters was done and there was highly statistically significant difference. According K readings; K1 was 46.22D in positive KC vs 42.34D in negative KC, K2 was 48.58D vs 44.5D, pachy Apex was 478 µm vs 530 µm, thinnest location was 472.5 µm vs 526.73 µm and kmax was 51.8D vs 45.15D.

A comparison between positive and negative keratoconus in group B is applied as regard all parameters were done and there was highly statistically significant difference. According K readings; K1 was 50.03D in positive KC vs 42.8D in negative KC, K2 was 55.08D vs 47.03D, pachy Apex was 450.13µm vs 526µm, thinnest location was 414.88µm vs 518.83µm and kmax was 59.6D vs 45.9D **(Table 3)**.

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Table (3): Comparison between –ve and +ve keratoconus in group A and group B.

Group A		Negative KC No. = 40	Positive KC No. = 12	P-value
Astigmatism(D)	Median (IQR)	2.25 (1.75 – 2.50)	2.38 (2.25 – 2.50)	0.516
	Range	1.5 – 3	1.5 – 3	
K1(D)	Mean ± SD	42.34 ± 0.80	46.22 ± 4.43	<0.001
	Range	40.9 – 44.5	38.7 – 55.4	
K2 (D)	Mean ± SD	44.50 ± 0.87	48.58 ± 4.57	<0.001
	Range	43 – 47	40.2 – 57.9	
Pachy Apex (µm)	Mean ± SD	530.00 ± 36.96	478.00 ± 55.84	<0.001
	Range	454 – 604	410 – 566	
Thinnest Location (µm)	Mean ± SD	526.73 ± 36.99	472.50 ± 56.30	<0.001
	Range	452 – 602	405 – 559	
K. Max (D)	Median (IQR)	45.15 (44.2 – 45.85)	51.80 (47.7 – 55.1)	<0.001
	Range	43.1 – 49.5	46.4 – 60.5	
Group B		Negative KC No. = 10	Positive KC No. = 18	P-value
Astigmatism (D)	Median (IQR)	4.25 (4 – 4.75)	4 (3.5 – 5.5)	0.738
	Range	3.25 – 5.25	3.25 – 8	
K1 (D)	Mean ± SD	42.80 ± 2.60	50.03 ± 7.63	0.008
	Range	38.9 – 47	43.4 – 71.3	
K2 (D)	Mean ± SD	47.03 ± 2.20	55.08 ± 7.77	<0.001
	Range	44 – 50.8	47.3 – 75.1	
Pachy Apex (µm)	Mean ± SD	526.00 ± 40.65	450.13 ± 41.73	<0.001
	Range	472 – 587	372 – 529	
Thinnest Location (µm)	Mean ± SD	518.83 ± 39.60	414.88 ± 52.08	<0.001
	Range	465 – 582	310 – 486	
Kmax (D)	Median (IQR)	45.9 (45.7 – 48)	59.6 (52.1 – 65.0)	0.006
	Range	45.4 – 52	51.4 – 91.6	

Mann-Whitney test, Independent t-test

A comparison between right eyes in both groups is applied as regard all parameters was done and there was highly statistically significant difference except in pachy Apex. According K readings; K1 was 43.54D in group A vs 48D in group B, K2 was 45.79D vs 52.6D, astigmatism was 2.25D vs 4.13D, pachy Apex was 516 µm vs 480.5µm, thinnest location was 512.19µm vs 458.93µm and kmax was 45.7D vs 52.1D.

A comparison between left eyes in both groups is applied as regard all parameters was done and there was highly statistically significant difference. According K readings; K1 was 42.92D in group A vs 45.86D in group B, K2 was 45.09D vs 50.66D, astigmatism was 2.5D vs 3.5D, pachy Apex was 520µm vs 484.79µm, thinnest location was 516.23µm vs 459.93µm and kmax was 45.3D vs 53.6D **(Table 4)**.

Table (4): Comparison between the different parameters in right and left eyes of both groups

Parameters \ Groups		Group A No. = 26	Group B No. = 14	P-value
Right:				
Astigmatism(D)	Median (IQR)	2.25 (1.75 – 2.50)	4.13 (3.75 – 5.0)	<0.001
	Range	1.5 – 3	3.25 – 7	
K1 (D)	Mean ± SD	43.54 ± 3.04	48.00 ± 9.25	0.030
	Range	41 – 55.4	38.9 – 71.3	
K2 (D)	Mean ± SD	45.79 ± 3.17	52.60 ± 9.44	0.002
	Range	43.1 – 57.9	44 – 75.1	
Pachy Apex (µm)	Mean ± SD	516.00 ± 48.17	480.50 ± 64.44	0.056
	Range	410 – 604	372 – 586	
Thinnest Location (µm)	Mean ± SD	512.19 ± 49.54	458.93 ± 69.75	0.008
	Range	405 – 602	333 – 582	
Kmax (D)	Median (IQR)	45.7 (44.2 – 47.0)	52.1 (48 – 60.5)	<0.001
	Range	43.1 – 60.5	45.4 – 91.6	
Left:				
Astigmatism (D)	Median (IQR)	2.5 (1.75 – 2.75)	3.5 (2.25 – 4.0)	0.020
	Range	1.5 – 3	3.25 – 8	
K1 (D)	Mean ± SD	42.92 ± 2.40	45.86 ± 3.51	0.003
	Range	38.7 – 50	39 – 51	
K2 (D)	Mean ± SD	45.09 ± 2.50	50.66 ± 4.11	<0.001
	Range	40.2 – 52	44.4 – 58.5	
Pachy Apex (µm)	Mean ± SD	520.00 ± 46.61	484.79 ± 47.77	0.030
	Range	415 – 596	407 – 587	
Thinnest Location (µm)	Mean ± SD	516.23 ± 46.38	459.93 ± 72.74	0.005
	Range	412 – 593	310 – 581	
Kmax (D)	Median (IQR)	45.3 (44.1 – 46.9)	53.6 (48.7 – 63.0)	<0.001
	Range	43.1 – 54.7	45.5 – 66.7	

Mann-Whitney test, Independent t-test

A comparison between positive and negative keratoconus in right eyes of both groups was done and there was statistically significant difference. A Comparison between positive and negative keratoconus in left eyes of both groups was done and there was statistically significant difference (**Table 5**).

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Table (5): Comparison between –ve and +ve keratoconus in right and left eyes of both groups

Parameters	Groups	Group A		Group B		P-value
		No.	%	No.	%	
Right:						
Result	Normal	20	76.9%	5	35.7%	0.024
	KC1	2	7.7%	1	7.1%	
	KC2	1	3.8%	3	21.4%	
	KC3	1	3.8%	3	21.4%	
	KC4	0	0.0%	2	14.3%	
	Suspicious	2	7.7%	0	0.0%	
KC	Negative	20	76.9%	5	35.7%	0.010
	Positive	6	23.1%	9	64.3%	
Left:						
Result	Normal	20	76.9%	7	50.0%	0.008
	KC1	0	0.0%	0	0.0%	
	KC2	2	7.7%	3	21.4%	
	KC3	0	0.0%	4	28.6%	
	KC4	0	0.0%	0	0.0%	
	Suspicious	4	15.4%	0	0.0%	
KC	Negative	20	76.9%	7	50.0%	0.083
	Positive	6	23.1%	7	50.0%	

DISCUSSION

Keratoconus is the most common primary non inflammatory ectatic disease of the cornea. It is one of the major indications for corneal transplant in the developed countries *(Sugar and Macsai, 2012).*

Since keratoconus is typically characterized by the progression of irregular astigmatism, thinner cornea, and increased steepening of corneal curvature. Keratoconus is often first detected in the course of an eye examination and patients may be unaware of it, even though they complain of poor vision and have sought ocular care. Knowing the query prevalence of subclinical and clinical KC introduces much earlier interventions to hold the progression of the disease and guard against one of the most common cause of blindness.

There is an increase in the number of cases occurring nowadays in the world which may be due to technology advancement or better methods of diagnosis like corneal tomography and topography which dramatically improved the sensitivity of the diagnosis and detection of these ectatic disorders. This study was carried out to evaluate the prevalence of KC in astigmatic patients attending Al-Sayed Galal University Hospital. Retrospective analysis of the data presented on pentacam (Oculus) was done.

In the current study, the prevalence of KC among the selected cases of astigmatic patient's ≥1.5D is (35%). This is a different finding from the prevalence of KC reported by *Shakir and Alwan (2019)* where 21% of the patients with astigmatism ≥ 2D attending the outpatient clinic. In our Study Group (A), the

prevalence of KC was 23%, nearly the same results as their study, but in Group (B), the prevalence of KC was 57%. So, the total prevalence of KC in our study was higher than the one performed by them. On the other hand, they found that the higher prevalence rates for keratoconus were found as cylindrical power increased, which is agreed with our study.

Concerning the Prevalence of KC regarding as gender distribution in this study, there was a slight gender predilection, 57.1% were males and 42.9% were females. *Shakir and Alwan (2019)* found that the female was predominant in which the prevalence rate was 61.1% and 38.9% for females and males respectively. This difference in results may be due to high male percentage in our study which include 55% vs 45% of females. They showed that the distribution as 54% females vs 46% males. In our study, there is no significant difference in keratoconus distribution between the two genders.

As regarding to the corneal parameters (mean anterior keratometer, pachymeter and the thinnest corneal thickness), *Safarzadeh et al. (2016)* reported similar results.

In our study, we have 6 cases that were diagnosed as unilateral keratoconus with suspicion in the other eye, *Gordon-Shaag et al. (2015)* found that more than one third of subjects with unilateral KC developed manifest KC in the other eye over 8 years. So, early diagnosis of subclinical and clinical keratoconic patients in grade 1and grade 2 is a very important point to all keratoconic patients, especially to astigmatic patient seeking for refractive correction procedures.

According to corneal topography, these astigmatic patients were diagnosed either non keratoconic or keratoconic. In cases that they are non keratoconic, different refractive procedures (Photorefractive keratectomy (PRK), LASIK and femtolasik) can be done safely. Therefore, patients diagnosed as keratoconus, should be warned from undergoing any of the refractive procedures.

Crosslinking (CXL) is the first surgical intervention, one of the earliest management steps to consider, especially in young patients. There should be no upper or lower age limit for CLX in KC eyes that show evidence of progression. CXL can delay keratoconus progression and decrease the demand for penetrating keratoplasty. Intracorneal ring segments (ICRS) induce an "arc-shortening effect" on the corneal lamellae and flatten the corneal center, as well as shift the corneal apex to a more central position that improves best-corrected visual acuity (BCVA) *(Coskunseven et al., 2011)*.

The study by *Ibrahim et al. (2016)* reported that ICRS insertion assisted by femtosecond laser and corneal CXL provided improvement in visual acuity and keratometry results, which seems to suggest that it may be an effective treatment for the correction of early grades of keratoconus.

Penetrating keratoplasty (PKP) has been considered as the gold standard for the treatment of advanced keratoconus *(Gordon-Shaag et al., 2015)*.

CONCLUSION

Subjects with 1.5D or more of astigmatism who present to outpatient clinics should undergo corneal topography screening for early diagnosis of KC even if visual acuity is not affected.

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دراسة معدل إنتشار القرنية المخروطية بين مرضى اللانقطية المصريين

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خلفيـــة البحــث: تعتبـر القرنيــة المخروطيــة مــن أهــم الأمــراض التــي تصــيب قرنيــة العـين وتسـبب حـدوث اضطـراب وتغيـرات هيكليـة داخـل القرنيـة ممـا يـؤدي إلـى تغيـر الشــكل الطبيعــى للقرنيــة إلـــى الشــكل المخروطــي واعوجــاج سـطح القرنيــة. وهــو مــرض تقـدمي غيـر التهـابي عـادةً مـا يحـدث فـي العينـين (ولكـن بصـورة غيـر متطابقـة) يحـدث اضـطراب الرؤيـة بالأسـاس بسـبب اللانقطيـة (الاسـتيجماتيزم) غيـر المنـتظم وقصـر النظـر ولوجـود تنـدب بسـطح القرنيـة. يختلـف معـدل انتشـار القرنيـة المخروطيــة للحــالات التــي تـم الإبــلاغ بهــا بــاختلاف الخريطــة الجغرافيــة والمعــايير المتبعة في التشخيص ومجموعة المرضى الذين تم اختيارهم.

الهـدف مــن البحـث: تحديـد وتقيـيم معـدل إنتشـار القرنيـة المخروطيـة والحـالات المشـتبه بهـا بـين مرضـى الاسـتيجماتيزم (1,5-) أو أكثـر مسـتخدمين الكـاميرا الخماسية (البنتاكام).

المرضـي وطـرق البحـث: أجريـت هـذه الدراسـة بعـد فحـص مرضـى الاسـتيجماتيزم بالعيـادات الخارجيـة الخاصـة بالرمـد فـي مستشـفى السـيد جـلال الجـامعى فـي الفتـرة مـن يونيـو2019وحتـي ديسـمبر2019، وتـم عمـل فحـص القرنيـة (البنتاكـام) هنـاك بالمستشـفى؛ وتضـمنت الدراسـة 80 عينًـا لعـدد 40 شـخص يعـانون مـن الاسـتيجماتيزم (- 1,5) أو أكثـر؛ كمـا كانـت أعمـارهم بـين (18-40) مـع عـدم وجـود أي أمراض أخرى بالعين.

نتـائج البحـث: أظهـرت النتـائج فـى المجموعـة (أ) معـدلات إصـابة بالقرنيـة المخروطيــة تُقـدر بنسـبة (23%) 6 أشـخاص مـن أصـل 26 شـخص؛ بينمـا فـى المجموعـة (ب)، كانـت معـدلات الإصـابة بنسـبة (57%) 8 أشـخاص مـن أصـل 14

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شـخص؛ بينمـا كـان معـدل الإصـابة بالقرنيـة المخروطيـة فـى مجمـوع الحـالات فـى المجمـوعتين (35%). وقـد أظهـرت نتـائج هـذه الدراسـة إرتفـاع معـدلات الإصـابة بالقرنيـة المخروطيـة خصوصًـا مـع ارتفـاع درجـات الاسـتيجماتيزم عنـد المرضـى, ومـع القيـام بعمـل مقارنـة مـع النسـب العالميـة لانتشـار القرنيـة المخروطيـة بـين مرضـى الاسـتيجماتيزم، كانـت النتـائج متقاربـة بعـض الشـيء خصوصًـا أن النسـب العالميـة (21%) متوافقـة مـع نسـب المجموعـة (أ) فـى هـذه الدراسـة ومـع ارتفـاع درجـات الاسـتيجماتيزم تـزداد نسـب الحـدوث خصوصًـا مـع الطفـرة فـى فحوصـات سطحي القرنية (الأمامي والخلفي) بإستخدام البنتاكام.

الاسـتنتاج: فحـص قرنيـة الأشـخاص الـذين يعـانون مـن الاسـتيجماتيزم (خصوصًـا مـع إرتفـاع درجاتـه) عـن طريـق الكـاميرا الخماسـية (البنتاكـام) يسـمح بالتشـخيص المبكـر بالتـدخلات المبكـرة، وبالتـالي الحـد مـن تطـور المـرض لتجنـب أو تـأخير الحاجـة إلـى ترقيع القرنية.

الكلمات الدالة: القرنية المخروطية، اللابؤرية، بنتاكام.