IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 5 Ver. IX (May. 2016), PP 117-123
www.iosrjournals.org

Keratoconus : An Evaluation of Clinico-etiological Factors and Diagnostic Modalities

Dr.Jitendra Kumar[1],Dr.Naveen Sirohi[2], Dr. Nitin Tiwari[3]
[1](*Associate Professor And H.O.D,Ophthalmology,M.L.B. Medical College,Jhansi,Uttar Pradesh,India)*
[2](*Junior Resident,Ophthalmology,M.L.B. Medical College,Jhansi,Uttar Pradesh,India)*
[3](*Junior Resident, Community Medicine ,M.L.B. Medical College,Jhansi,Uttar Pradesh,India)*

Abstract
Purpose : *The purpose of this prospective study is to present the epidemiological information known and the factors believed to cause the development of the disease and to evaluate the corneal topography and pachymetry of young patients suffering with keratoconus.*
Methods: *The study comprised of 36 eyes of 18 patients of keratoconus attending the outdoor unit of Department of Ophthalmology, Maharani Laxmi Bai Medical College, Jhansi between July 2015 and April 2016. Data were collected on demographic characteristics, general health, family history, eye rubbing, allergy, asthma, eczema, education level, history of keratoplasty, contact lens use and smoking. All eyes of patients with keratoconus were studied by means of corneal topographic and pachymetry analysis. Quantitative topographic parameters were analyzed with special reference to the central point of the cornea, the apex (the point with maximum reading on the anterior elevation best-fit sphere map), and the thinnest point. Evaluation included location, elevation (compared to a bestf it sphere), pachymetry, tangential curvature, and composite curvature.*
Results: *Mean patient age was 25.6 years ± 8.2 (range 9 – 32 years). Fifteen patients(83.3%) had bilateral keratoconus(including subclinical) and 3 (16.6%), unilateral keratoconus. Out of them 4 cases were having subclinical keratoconus and there were 3 topographically normal eye of 3 unilateral keratoconus patients. 11 (61%) patients had positive family history of the disease, 14 (77.8%) patients belong to male gender and 9 (50%) cases had manifestation of atopy. Keratoconic topographic alterations were : majority of the patients, 14 (77.8%) had peripheral cones, with steepening extending to the limbus, the steepening was commonly restricted to one or two quadrants. In some cases, however, the changes involved nearly the entire corneal surface. The remaining (22.3%) patients had steepening that was restricted to the central cornea.Most cones (28/33) were located in the inferior temporal quadrant; 5 were above the horizontal meridian.*
Conclusion: *Positive family history, male gender and atopy were shown to be predictors of the disease . The results of this study signal a need for public health outreach and intervention for keratoconus. Corneal Topography can provide useful and accurate information in defining the morphology of keratoconus and detecting subtle topographic changes present in early keratoconus in young patients. It may also improve the results of contact lens fitting and surgical management.*
Keywords: *Keratoconus, Risk factors, Corneal Topography, Corneal Pachymetry*

I. Introduction

The term keratoconus (KC) comes from the Greek words keras (horn) and konos (cone) and the condition has beenknown since the middle of the 19th century. KC is a developmental anomaly in which the inferior or central portion of the cornea becomes thinner and bulges forward in a cone-shaped fashion as a result of noninflammatory thinning of the corneal stroma[1]. Thinning of the superior portion of the cornea has been reported but is very rare. The corneal thinning induces irregular astigmatism and myopia leading to mild to marked visual impairment[2].

The disease has its usual onset at puberty and in many cases progresses until the third to fourth decade of life, when it usually arrests[1]. In the vast majority of cases (in excess of 90%), keratoconus is bilateral, although usually asymmetric in severity and progression. In many cases, the disorder may start unilaterally, but eventually, the other eye becomes involved.

Early stages of the disease may not be accompanied by any symptoms, but as it progresses, the main symptom is mild to severe visual impairment due to irregular astigmatism, myopia and frequently, corneal scarring. As the disease progresses irregular astigmatism resulting in 'scissoring', reflex is noted when performing retinoscopy. Later, partial or complete accumulation of iron deposits may be seen around the base of the KC cone called Fleischer's ring and Vogt's striae, which are vertical lines produced by compression of Descemet's membrane may be seen near the apex of the cone. Corneal scarring is also common. In advanced cases of KC, the ectatic cornea becomes visible to an observer and on looking downward the protrusion will push the lower lid out in a v-shaped dent called Munson's sign. In extremely advanced and severe cases, breaks

in Descemet's membrane referred to as hydrops have been observed. These breaks cause stromal edema, vision loss and associated pain.The predominant optical aberration of a keratoconic eye is coma5[3] and the cone becomes less touch-sensitive[4]. The condition is associated with a multitude of diseases[2],such as Down syndrome, Ehlers-Danlos syndrome, Leber's congenital amaurosis, osteogenesis imperfecta and connective tissue disorders.

The aetiology of the disease is still unclear, although genetic[5] and environmental factors[6] influence the development of keratoconus. The cause is clearly multi-factorial. The disease may be triggered by environmental factors in genetically susceptible individuals5] . A strong indication of genetic influence comes from a positive family history of keratoconus in patients afflicted by the disease. Reports vary from 3.34 per cent in first-degree relatives to 23.5 per cent in close and distant relatives[7]. Moreover, in the last few years it has been reported that the prevalence of the disease varies among ethnic groups which may reflect genetic or geographical influences. A positive association between KC and many conditions has been suggested and ocular allergy is one of them. The various ocular allergic conditions that have been associated with KC includes vernal keratoconjunctivitis (VKC), atopic keratoconjunctivitis and seasonal or perennial allergic keratoconjunctivitis[8]. Studies had shown that individuals with keratoconus and atopy had a steeper and thinner ectatic area than individuals with keratoconus but without atopy[9]. There seems to be an association between keratoconus and eye rubbing[10]. There seems to be some evidence supporting the role played by ultraviolet radiation, as a high prevalence of the disease has been reported in hot, sunny countries, such as India[11].

The most sensitive method of detecting early KC is corneal topography. Typical patterns of irregular astigmatism are described by Rabinowitz[2]. Corneal topography has become more commonplace and routine in ophthalmic practice and is now seen as the gold standard test in diagnosing and monitoring KC. The topographic patterns of KC corneas differ qualitatively and quantitatively from normal corneas. Qualitatively, the most common KC pattern is an asymmetric bow -tie with a skewed rad ial axi s (Fig.1). The quantitative topographic characteristics of keratoconus are an increased area of corneal power and inferior-superior (IS) power asymmetry.

The diagnosis of keratoconus on the basis of pachymetric evaluation has been attempted in the past. Tthe difference between the superior and inferior corneal thickness as noted on ultrasonic pachymetry can be used to grade keratoconus[12]. Orbscan pachymetry-based indices to be both sensitive and specific for diagnosing keratoconus[13]. A useful measure of the asymmetrical paracentral thinning seen in keratoconus is the difference between the central and the minimum corneal thickness (MCT). Therefore, the difference between the central and MCT was independently analyzed.

Management of early cases of the disease is usually achieved with spectacles. As the disease progresses and the astigmatism worsens, specialised types of rigid contact lenses become the principal therapeutic method[14]. In advanced to severe cases and when the patient has become intolerant to contact lenses and/or good vision cannot be attained with contact lenses, keratoplasty is performed. About 10 to 25 per cent of keratoconic patients are managed surgically[15]. Lately, intrastromal corneal ring segments[16] and collagen cross-linking therapy[17] have become surgical options in the treatment of keratoconus and can be combined with contact lenses.

II. Materials and Methods

This prospective study was conducted at Department of Ophthalmology, Maharani Laxmi Bai Medical College, Jhansi between July 2015 and April 2016. Consecutive young myopic candidates presenting to our hospital for keratometric analysis were included in the study. The indications acceptable for inclusion in the study were: screening for lasik surgery, high astigmatism, frequent change of glasses, or a clinical diagnosis of keratoconus. Those with a history of any ocular surgery or any other ocular morbidity including poor ocular surface, dry eyes and contact lens wearers were excluded. Patients with secondary keratoconus and acute hydrops were excluded.

The questionnaire asked questions relating to age, gender, domicile, ethnicity, education level, family history of KC, contact lens wear, allergies, eye rubbing and smoking. Regarding eye rubbing the question was: do you regularly rub your eyes? Yes/no and followed by a range from"not at all" to"almost constantly". Regarding atopy the questions were: do you have any allergies? Yes/ no and followed by a list of environmental allergens, house dust/cat or dog hair/pollen/penicillin/other and asthma/eczema/hay fever.

Both eyes of patients underwent Orbscan / Pentacam Topographic anterior segment analysis and OCT (Optical Coherence Tomography) Corneal Pachymetry for corneal thickness measurements. The quantitative data were expressed in terms of Mean with SD (standard deviation) and percentage while qualitative data designed with 'yes or no'.

Any one of these conditions and of the allergens was considered positive. The nature of the study was explained to the patients with an an. The study followed the tenets of the Declaration of Helsinki.

III. Figures And Tables

Figure 1: Axial Corneal Topography map of right (OD) and left (OS) eyes of a 9 years old female patient showing bilateral and symmetrical "bow-tie" pattern.

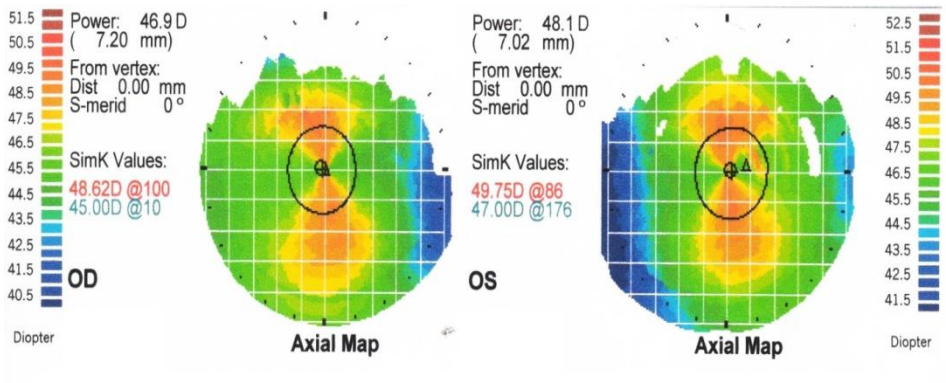

Figure 2: OCT Pachymetry scan of 22 years old male patient with bilateral keratoconus showing minimum corneal thickness of 431 and 426 μm in right and left eye respectively.

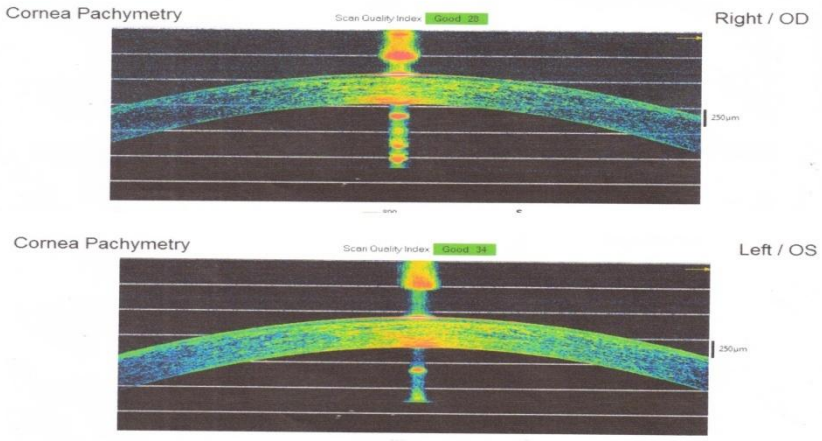

Figure 3: Corneal Topography image of both eyes of a 27 years old male patient showing asymetrical lesion with peripheral cones and inferior steepning.

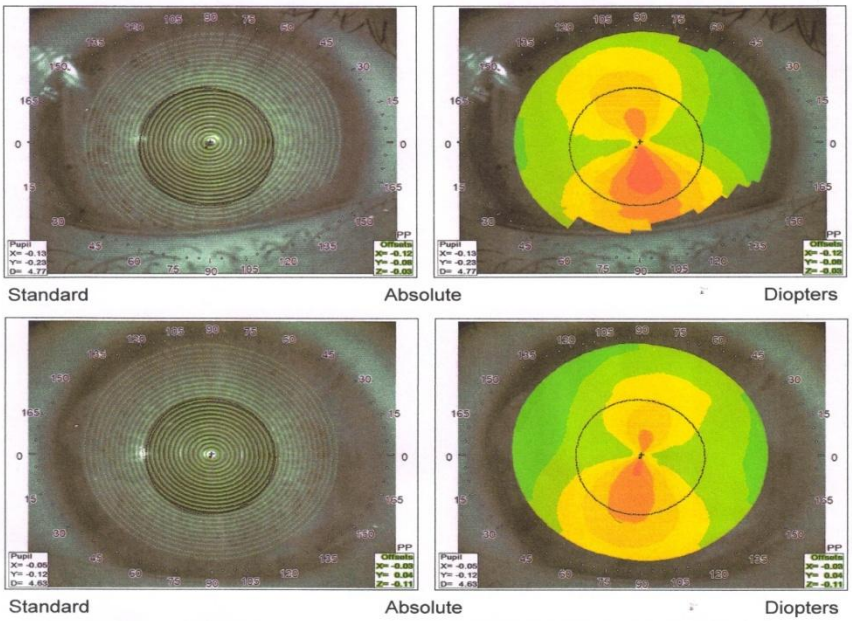

Figure 4: Oculus Pentacam sagittal curvature maps of a 32 years old male patient showing asymmetric keratoconus

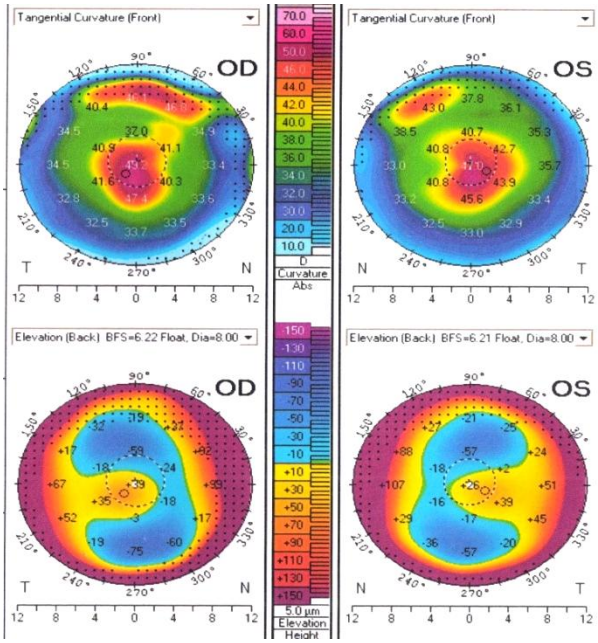

Figure 5: Orbscan image of both eyes of a 26 years old male patient with asymmetric keratoconus.

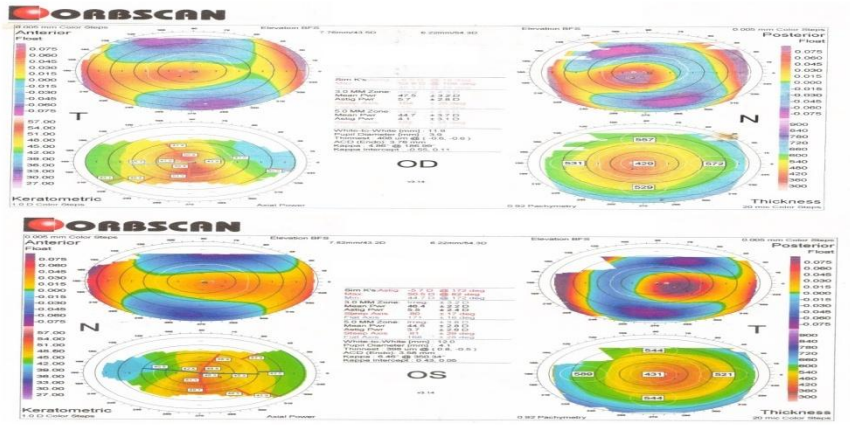

Table 1: Demographic and Diagnostic profile (n=18,%)

Mean age (years)	**25.6 ± 8.2**
Gender	
Male	14 (77.8)
Female	4 (22.2)
Keratoconus	
Bilateral symmetrical	9 (50)
Bilateral asymmetrical	6 (33.3)
Unilateral	3 (16.7)
Subclinical	4 (22.2)

Table 2: Predisposing / Associated factors

Factors	**Keratoconus subjects (n=18,%)**

First degree relative with keratoconus	11 (61)
Eye rubbing	10 (55.6)
Atopy	9 (50)
UV radiation exposure	9 (50)
Smoking	2 (11.1)

Table 3: OCT Pachymetry and Topography changes

Parameters	**Readings in diopter ± SD (range)**		
	Keratoconus cases	**Subclinical cases**	
Average spherical error	-7.5 ± 5.1D (-20.5 to 0)	-3.4 ± 2.1D (-5.75 to 1.25)	
Average astigmatism	3.2 ± 2.2D (0 to -6.5)	0.8 ± 0.6D (0 to -2.75)	
Average keratometer readings(SimK)	49.0 ± 5.2D (40.8 to 60.9)	43.0 ± 1.2D (41 to 47)	
Parameters (□m± SD)	**Keratoconus cases**	**Subclinical cases**	**Cut-off taken[2,13,23]**
Minimum corneal thickness(MCT)	442 ± 60.3	548 ± 22.7	433 ± 55
Minimum – median	-95.0 ± 4.4	-44.0 ± 7.1	-62.6
Inferior-superior(IS)	-44.1 ± 27.2	-9.3 ± 8.9	-31.3
Inferotemporal-superonasal(IT-SN)	-62.0 ± 33.5	-21.0 ± 10.2	-48.2
Vertical location of minimum	-801 ± 468	-112 ± 250	-716
KISA% indices	2633 ± 5020	188 ± 58	>100%

IV. Results

In all, 36 eyes of 18 patients suffering from keratoconus were included in the study. The average age was 25.6 years ± 8.2 (range 9 – 32 years). 14 (77.8%) male and 4 (22.2%) female patients participated in our study (Table.1).

Fifteen patients (83.3%) had bilateral keratoconus (including subclinical) and 3 (16.6%), unilateral keratoconus. Out of them 4 cases were having subclinical keratoconus and there were 3 topographically normal eye of 3 unilateral keratoconus patients. Subclinical keratoconus was characterized by inferotemporal thinning of the cornea, epithelium, and stroma. Among bilateral cases, 18 (50%) eyes of 9 patients had symmetrical disease (Table.1). 11 (61%) patients had positive family history of the disease, and 9 (50%) cases had manifestation of atopy (Table.2). Eye rubbing was reported by 10 keratoconic subjects (55.6 %). These data relate to any level of eye rubbing; however, the frequency of rubbing varied among individuals.

The mean refractive error in patients of keratoconus was -7.5 ± 5.1D spherical error with 3.2 ± 2.2D astigmatism and in subclinical cases was -3.4 ± 2.1D spherical error with 0.8 ± 0.6D astigmatism . . The keratometric variables assessed were simulated keratometry (Sim K) astigmatism, mean Sim K, and overall maximum keratometry in the central 10-mm zone (the central 10 mm was included as some cases of keratoconus suspect have early topographic changes in the zone outside the keratometrically measured 3 mm). Mean keratometry readings (SimK/Simulated Keratometry) were 49.0 ± 5.2D in keratoconus cases and 45.5 ± 1.2D in subclinical cases (Table.3).

OCT corneal topography (Fig.2) readings are shown in Table 3. The cut off values taken were 433 ± 55 μm in keratoconus and 522 ± 38 μm in normal eyes[2]. The mean KISA% indices were 2633 ± 5020 for keratoconus group and 188 ± 58 for subclinical cases. Details on KISA% index are given in the study by Rabinowitz and Rasheed[18]. In this index, an eye with a value between 60 and 100% is considered as a keratoconus suspect and that with a value >100% is considered as keratoconic.

Keratoconic topographic (Fig 3,4) alterations were : majority of the patients, 14 (77.8%) had peripheral cones, with steepening extending to the limbus, the steepening was commonly restricted to one or two quadrants. In some cases, however, the changes involved nearly the entire corneal surface. The remaining (22.3%) patients had steepening that was restricted to the central cornea.Most cones (28/33) were located in the inferior temporal quadrant; 5 were above the horizontal meridian.

V. Discussion

In accordance with recent studies, this study also gave preponderance of men over women[19]. The results of this survey confirm the role of eye rubbing as an important association and our data are similar to other studies, in which the results ranged from 40 per cent for gentle rubbing[20] to 73 per cent for an abnormal amount of rubbing[21]. More recent studies have proved that there is a definite association between allergy and KC. Atopy has been seen in majority of patients in our study too. Another study from India revealed a higher prevalence of allergy in these patients[22]. An association was also found with history of UV exposure in our

patients. UV radiation may be related to keratoconus. A large prevalence of the disease has been observed in countries with a lot of sun exposure and dry conditions for most of the year as prevails as in India[11]. Prevalence is much lower in areas with less sun exposure and lower average annual temperatures.

Computer-assisted videokeratography and the color coded map provide an abundance of information about corneal surface characteristics. However, human visual interpretation is essentially subjective, whereas contour information is difficult to analyze quantitatively. An objective assessment of videokeratography is essential for statistical studies of the progression of keratoconus, genetic studies, or screening procedures used for refractive surgery practice. Rabinowitz and McDonnell[23] reported the first numerical method to differentiate between keratoconus patterns and normals based on videokeratoscopy. They used central corneal power, difference in central corneal power between fellow eyes, and the Inferior- Superior (I-S) value. The I-S value was defined as an average refractive power difference between five inferior points and five superior points 3 mm from the center at 30° intervals. These three parameters were different in patients with keratoconus than in normal controls. To detect topographic characteristics of keratoconus quantitatively, the use of multiple parameters, each of which represents distinctive characteristics of the map, is desirable. Keratoconus patterns in videokeratoscopy can be characterized by an area of localized, abnormal steepening. Localized steepening is often observed in the inferior quadrant, but sometimes it is seen in the center or superior portion of the cornea[24]. This results in asymmetry and a large refractive power difference across the corneal surface.

Pachymetric diagnostic cutoffs can be used as adjuncts to the existing topographic criteria to screen keratoconus suspect and keratoconic eyes. Watters and Owen[12] demonstrated that the difference between the superior and inferior corneal thickness as noted on ultrasonic pachymetry can be used to grade keratoconus. Pflugfelder et al[13] found Orbscan pachymetry-based indices (Fig.5) to be both sensitive and specific for diagnosing keratoconus. Li et al[25] demonstrated that optical coherence tomography (OCT) pachymetry (Fig.2) maps can detect the characteristic abnormal corneal thinning in keratoconic eyes in a manner as sensitive and specific as the keratometric KISA% index. These studies have suggested that pachymetric difference in normal and keratoconic corneas exist, and can be used (in automated systems like OCT and Orbscan) to diagnose keratoconus.

VI. Conclusion

This study describes various associated features of keratoconus. Ocular allergy/ Atopy has an important role in pathogenesis, disease progression, and the treatment outcome in cases of KC. The high prevalence of positive family history of the disease in this study suggests a genetic influence. Patients and parents deserve proper knowledge regarding the disease course, risk of progression and possible alternatives. The measures, along with allergy control, enabling the patient to reduce eye rubbing are important for stabilization of ectasia. Clinical workup with complimentary examinations like Corneal Topography and Pachymetry shoulb be documented for such patients. The ability to screen for keratoconus patterns will be a beneficial tool in the clinician's armamentarium. With experience, the examiner can interpret topographic abnormalities based on the indices and can gain new insight into the relationship between the appearance of the color-coded map and specific measures of corneal power distribution. It may also improve the results of contact lens fitting and surgical management.

References

[1]. Krachmer JH, Feder RS, Belin MW. Keconratous and related noninflammatory corneal thinning disorders. Surv Ophthalmol 1984;28:293–322.
[2]. Rabinowitz YS. Keratoconus. Surv Ophthalmol 1998;42:297–319.
[3]. Gobbe M, Guillon M. Corneal wavefront aberration measurements to detect keratoconus patients. Cont Lens Anterior Eye 2005; 28: 57–66.
[4]. Millodot M, Owens H. Sensitivity and fragility in keratoconus. Acta Ophthalmol (Copenh) 1983; 61: 908–917.
[5]. Rabinowitz YS. The genetics of keratoconus. Ophthalmol Clin North Am 2003; 16: 607–620, vii
[6]. Kenney MC, Brown DJ. The cascade hypothesis of keratoconus. Cont Lens Anterior Eye 2003; 26: 139–146.
[7]. Wang Y, Rabinowitz YS, Rotter JI, Yang H. Genetic epidemiological study of keratoconus: evidence for major gene determination.AmJ Med Genet 2000; 93: 403–409.
[8]. Krachmer JH, Feder RS, Belin MW. Keratoconus and related noninflammatory corneal thinning disorders. Surv Ophthalmol. 1984;28:293–322.
[9]. Kaya V, Karakaya M, Utine CA, Albayrak S, Oge OF, Yilmaz OF. Evaluation of the corneal topographic characteristics of keratoconus with orbscan II in patients with and without atopy. Cornea 2007; 26: 945–948.
[10]. Weed KH, MacEwen CJ, Giles T, Low J, McGhee CN. The Dundee University Scottish Keratoconus study: demographics, corneal signs, associated diseases and eye rubbing. Eye (Lond) 2008; 22: 534– 541.
[11]. Jonas JB, Nangia V, Matin A, Kulkarni M, Bhojwani K. Prevalence and associations of keratoconus in rural Maharashtra in central India: the central India eye and medical study. Am J Ophthalmol 2009; 148: 760–765.
[12]. Watters GA, Owens H. Evaluation of mild, moderate, and advanced keratoconus using ultrasound pachometry and the EyeSys videokeratoscope. Optom Vis Sci 1998; **75**(9): 640–646.
[13]. Pflugfelder SC, Liu Z, Feuer W, Verm A. Corneal thickness indices discriminate between keratoconus and contact lens-induced corneal thinning. Ophthalmology 2002; 109(12): 2336–2341.

[14]. Lass JH, Lembach RG, Park SB, Hom DL, Fritz ME, Svilar GM, Nuamah IF et al. Clinical management of keratoconus. A multicenter analysis. Ophthalmology 1990; 97: 433–445.
[15]. Gordon MO, Steger-May K, Szczotka-Flynn L, Riley C, Joslin CE, Weissman BA, Fink BA et al. Baseline factors predictive of incident penetrating keratoplasty in keratoconus. Am J Ophthalmol 2006; 142: 923–930.
[16]. Colin J, Cochener B, Savary G, Malet F. Correcting keratoconus with intracorneal rings. J Cataract Refract Surg 2000; 26: 1117–1122.
[17]. Snibson GR. Collagen cross-linking: a new treatment paradigm in corneal disease—a review. Clin Experiment Ophthalmol 2010; 38: 141–153.
[18]. Rabinowitz YS, Rasheed K. KISA% index: a quantitative videokeratography algorithm embodying minimal keratometric criteria for diagnosing keratoconus. J Cataract Refract Surg 1999; 25(10): 1327–1335.
[19]. Owens H, Gamble G. A profile of keratoconus in New Zealand. Cornea 2003; 22: 122–125.
[20]. McMonnies CW, Boneham GC. Keratoconus, allergy, itch, eye-rubbing and hand-dominance. Clin Exp Optom 2003; 86: 376–384.
[21]. Karseras AG, Ruben M. Aetiology of keratoconus. Br J Ophthalmol 1976; 60: 522–525.
[22]. Agrawal VB. Characteristics of keratoconus patients at a tertiary eye center in India. J Ophthalmic Vis Res. 2011;6:87–91.
[23]. Rabinowiiz YS, McDonnell PJ. Computer-assisted corneal topography in keratoconus. Refract Corneal Surg. 1989; 5:4*00-408.
[24]. Wilson SE, Lin DTC, Klycc SD. Corneal topography of keratoconus. Cornea. 1991; 10:2-8.
[25]. Li Y, Meisler DM, Tang M, Lu AT, Thakrar V, Reiser BJ et al. Keratoconus diagnosis with optical coherence tomography pachymetry mapping. Ophthalmology 2008; 115(12): 2159–2166.