Review article on selection of base curve in rigid gas permeable contact lenses in keratoconus patients.

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Abstract - Our goal is to review relevant, recent articles on using RGP contact lenses to manage keratoconus. Finally, 10 studies were chosen and evaluated. A bilateral and asymmetric illness called keratoconus causes the cornea to gradually thin and steepen, which results in uneven astigmatism and impaired visual acuity. In the usual course of things, keratoconus appears in the second and third decades of life and worsens until the fourth decade.Keratoconus is prevalent (0.0003-2.3%) from 0.3/100,000 in Russia to 2300/100,000 in Central India. Depending on the severity and course of the condition, keratoconus treatment differs. The conventional treatment for mild cases is eyeglasses, for moderate cases contact lenses, and for severe cases that cannot be controlled with scleral contact lenses, corneal surgery.The definition, epidemiology, classification, and management of keratoconus using RGP contact lenses are all updated in this article.

1. Introduction:-
Myopia, uneven corneal astigmatism, and reduced vision as a result of corneal thinning and protrusion are all symptoms of the progressive non-inflammatory ectatic disorder keratoconus [1]. When the syndrome is present, patients typically experience corneal thinning, which, if addressed, can worsen and lead to corneal ectasia. While keratoconus in adults has received substantial research, little is known about the condition in children. Compared to adult keratoconus, pediatric keratoconus is more aggressive [2]. Adult patients can currently benefit from penetrating keratoplasty, deep anterior lamellar keratoplasty (DALK), corneal cross-linking, intracorneal rings segments, glasses, contact lenses, and other treatments that have already been tried on pediatric patients.the various keratoconus severity categorization methods currently in use, which take into account factors such as corneal morphology and disease progression, optical and visual function, and descriptors of corneal shape (i.e., index-based systems).

2. Histopathology:-
Although early stages of the disease only the anterior cornea appears to be compromised [28], all corneal layers have been reported to experience histopathological changes in keratoconus, which are much more pronounced in the central compared to the peripheral cornea. Although corneal epithelial thinning around the apical cone region is thought to be the most common histopathological change associated with keratoconus [29], some studies have reported either no significant [30]. Some studies have reported either no significant change [31].Additionally, one study indicated that epithelial thickening was linked to cracks in the anterior limiting lamina, while another found that epithelial thinning was inversely correlated with the severity of the disease [32]. While another study discovered that epithelial thickening was connected to fractures in the anterior limiting lamina [33].

Furthermore, it has been proposed that collagen lamellae are expanded in association with the protrusion of the cone [34]. A gross rearrangement of vertical and horizontal collagen lamellae occurs in keratoconus [35]. A decrease in the interfibrillar distance of collagen sheets and the increase of proteoglycans have also been reported [36]. Ectasia and thinning in keratoconus are associated with lamellar splitting into multiple bundles of collagen fibrils and loss of anterior lamellae. These structural changes, possibly in addition to the lateral shifting of lamellae due to the pressure gradient over the cornea, provide a potential explanation to the central loss of mass ultimately leading to reduced stromal thickness [37]. Using confocal microscopy, alternating dark and light bands, often located in the posterior stroma, have been observed in people with keratoconus [38]. These bands match the appearance of Vogt's striae under slit-lamp biomicroscopy and are thought to represent collagen lamellae under stress.

Although the corneal endothelium is typically untouched by keratoconus, this matter remains debatable [39]. While numerous investigations discovered no endothelium changes as the disease developed [40]. Two studies found a considerable decrease in endothelial cell density, especially in moderate to severe keratoconus, while one found a modest rise in endothelial cell density in keratoconus [41]. while two others reported a significant decrease in endothelial cell density, particularly in moderate to severe keratoconus [42].

3. Clinical features:-
There is no universal agreement on the signs and symptoms of early keratoconus, however, the disorder commonly affects both eyes in varying degrees of severity and has well-established signs and symptoms [43]. Although there are no universal standards for the usage of these two names, subclinical or form-fruste keratoconus are typical terms for the disease's early phases [44]. Form fruste keratoconus often refers to an eye having keratoconus in the neighboring eye as well as normal topography and corneal slit-lamp findings in the healthy eye.
The clinical symptoms of keratoconus are varied. In the course of retinoscopy evaluation, the "scissor reflex" is seen. Retroillumination with a dilated pupil is also frequently used to see Charlouex's oil droplet reflex in early keratoconus, which

results in a dark, oblong shadow in the eye [45].Fleischer's ring, which appears as an arc or ring-shaped pigmentation at the base of the cone, is thought to be a subepithelial deposition of iron oxide hemosiderin within the posterior limiting lamina membrane [46]. Vogt's striae are thin to moderately thick, vertical stress lines that appear in the posterior stroma and posterior limiting lamina as a result of stretching and thinning of the cornea and vanish when gentle pressure is applied to the globe. They can also have a fan-like appearance at the base of the cone.On rare occasions, striae can be seen without a slit lamp. Patients with keratoconus exhibit Fleischer's ring and Vogt's striae in one or both eyes in 86 percent and 65 percent of cases, respectively [47] and it has been suggested that the presence of these two symptoms may help confirm the diagnosis in cases where it is uncertain [48]. Additionally, keratoconus patients frequently experience both superficial and deep corneal opacities, as well as increased corneal nerve visibility [49] Vogt's striae, Fleischer's ring, and/or corneal scarring, are more likely to be present when the disease is more advanced, even though they might appear at any stage of the disease's development and progression [50].

Additionally, keratoconus patients who have corneal staining, greater corneal curvature (i.e., >55 D or steeper than 6.13 mm), and who wear contact lenses are more likely to experience epithelial or subepithelial corneal scarring [51]. This confocal microscopy observation of stromal haze and hyperreflectivity also matches the slit lamp finding [28].The Munson's sign, a V-shaped deformation of the lower eyelid during downgaze, can occur in extreme cases where excessively prominent cones are present. Another indication that is usually seen in advanced phases is Rizzuti's sign, which is a bright reflection of the nasal area of the limbus when light is directed to the temporal limbal area [32]. A break in the posterior limiting lamina, which enables aqueous to enter the corneal stroma and epithelium, may cause corneal hydrops, which are marked by corneal oedema. This condition is caused by severe keratoconus. Even though hydrops can go away on its own in around three months, severe instances can need corneal suturing or intracameral gas injection [31]. Scar tissue and irregular corneal surface caused by corneal hydrops can impede central vision, making scleral implants necessary in many instances.

4.1 Morphological (Buxton) classification [32]
Based on the location and shape of the cone, this method divides the condition into three categories: globe, nipple, and oval keratoconus .(1) In globe keratoconus, the cone affects a significant portion of the anterior cornea (>75 percent). (2) In oval keratoconus, the cone affects one or two corneal quadrants, with the inferior quadrant being the most frequently affected location. (3) In nipple keratoconus, the cone diameter is 5 mm and is located in the central or paracentral cornea.

4.2 Keratometric classification [24]
Based on the size of the cornea's central corneal power, this approach divides keratoconus into four grades: mild (45 D), moderate (between 46 D and 52 D), advanced (between 53 D and 59 D), and severe (>59 D).

4.3 Hom's classification [25]
Based on clinical findings, this method divides keratoconus into four grades: Preclinical keratoconus is indicated by the absence of visible keratoconus symptoms; mild instances show modest corneal thinning and scissors reflex; moderate cases show corneal thinning without corneal scarring; and severe cases show corneal scarring, inconsistent refraction, and severe corneal thinning.

5. The prevalence of keratoconus:-
From 0.3/100,000 in Russia to 2300/100,000 in Central India, keratoconus is prevalent (0.0003-2.3%) [3]. Our tertiary care facility has a prevalence of 5200/100,000 cases (5.2 percent). Due to different diagnostic standards and the examined populations' heterogeneity, such a wide range is observed [4]. Two survey studies from the United Kingdom show that Asians (Indian, Pakistani, and Bangladeshi) have a 4.4–7.5 times higher prevalence than Caucasians, indicating that race plays a big part in health [5].Both sexes are affected by keratoconus, however, it's unknown whether there is a noticeable difference between men and women [6]. of the 5200 cases, we saw overall over seven years (unpublished data, January 2007 to January 2014), There were 5044 (97%) cases with bilateral involvement, including 2440 (46%) males and 2760 (53%) females. On topographical investigation, even patients with unilateral involvement on clinical examination had bilateral early keratoconus or forme-fruste. It has been discovered that there are a variety of family histories with keratoconus, ranging from 6% to 21.74 % [7]. In our sample, there were 94 patients with a positive family history.

Only the anterior corneal power acquired by keratometry was used to study the prevalence of keratoconus in Central India. Keratoconus prevalence, measured as a corneal refractive power 48 D, was 2.3%. However, with a limit of 50 diopters, the prevalence decreased to 0.1 percent and 0.6 percent, respectively [8].The wide variance in prevalence may be attributed to environmental factors. regions with a lot of sunshine and warm temperatures, like India [9]. compared to places with colder climates and less sunlight, such as Finland[10] Denmark(11), Minnesota [12], Japan [13], Russia, and the Middle East [14] .The inability of keratoconic corneas to withstand ultraviolet light-induced oxidative damage may be a factor [15].

6. Management of keratoconus:-
The severity and progression of the illness affect how keratoconus is managed. The usual treatment for mild cases is eyeglasses, for moderate cases contact lenses, and for severe cases that cannot be controlled with scleral contact lenses, corneal surgery.
6.1 moderate keratoconus Only moderate forms of keratoconus can be treated with spectacles, and they frequently lead to poor visual acuity [26].Moderate keratoconus.

6.2 Currently, contact lenses are used by an estimated 90% of patients with corneal irregularities [27] Gas permeable contact lenses (i.e., corneal, corneoscleral, and scleral), piggyback systems (i.e., a rigid corneal lens attached on top of a soft contact lens), soft contact lenses, and hybrid lenses (i.e., rigid center and soft peripheral hydrophilic skirt) are some of the options for managing keratoconus.Severe keratoconus.

6.3 Scleral lenses may be used to treat severe cases of keratoconus, especially when conventional lens options often fail to provide a physiologically acceptable fit [28]. In these situations, corneal surgery may be necessary, including corneal cross-linking, refractive surgery, corneal transplantation, or a combination of numerous refractive surgical treatments, if contact lens fitting fails.

7. Discussion:-

It is exciting to choose a rigid lens BC accurately using information from keratometry or the Oculyzer, but the literature does not offer enough proof to back this up. Previous research has suggested that the flatter keratometry value should fit RGP CL initial BC selection [22].The author of a study by Lin et al. discovered a similar finding: the patient's flatter k had a substantial link with the chosen lens BC. As the average of the flatter KR was 7.4mm, they also suggested a formula to calculate the BC for the patients: BC=4.742+0.364krf1. However, for any change of 0.3mm in KR above or below the average, BC needed to be changed by 0.1mm, as well. The authors concluded that BC becomes flatter than KRF below 7.4mm and steeper than KRF beyond 7.4mm. The Lin et al study's single formula makes rigid contact lens fitting straightforward, although it appears that alternative formulas are also required due to changes in KR

In research by Zednik et al., the authors state that no particular formula could be used to fit rigid contact lenses in keratoconic patients, although lens BC is closer to the flattest keratometry findings during the early stages of the disease and the steeper the lens BC, the more progressed the disease. They concluded that lens BC changes occur later than changes in corneal BC and that in cases of advanced disease, the lens BC should be selected to be flatter than the flattest curve detected by keratometry [23]. This study's conclusion that no one formula will always fit stiff contact lenses is supported by recent research. However, based on the measurement of corneal curvature, the closest BC can be estimated. Patients' levels of keratoconus severity vary, which presents eye care professionals with a diverse range of corneal radial curves in various patients. Therefore, selecting just one BC for a patient's lens trial and then selecting lens power as the first fit will result in selecting a steeper or flatter lens for that patient, which requires different adjustments to fit the lens. It seems preferable to select various BCs for various keratoconus stages and then determine lens power by over-refraction after fitting. In this research, we found KRF to be a powerful predictor of BC in different groups of keratoconus patients. The classification of the patients into five groups and the separate analysis of the data in each group allowed us to minimize potential biases and reinforce the results, which is the strength of the current study. Because independent observations would be broken if left and right eyes were linked in the dependent variable, this study's fundamental flaw is its inability to compare the correlation between left and right eyes. The literature has covered this subject [24].

In their study, Mohammad Taher Rajabi et al. divided all keratoconus patients into five categories and reported that the formulas to be used to choose the initial BC in rigid contact lens fitting were BC=0.321xkrf+5.219 for the group with a difference between the two keratometry measurements, flat and steep=0.3-0.6, and BC=0.337xkrf+5.090 for the group with KRF-KRS >0.6mm [25]. However, in the current study, all of the patients were divided into seven different groups, and it is advised to select average simulated k for the group of patients with a difference between flat and steep keratometry (0.3-0.6) and flat simulated k for the group of patients with KRF-KRS >0.6mm when deciding on the initial BC.

8. In summary:-

Although rigid gas-permeable contact lenses are an important part of treating keratoconic patients, proper lens fitting techniques are crucial to improving the likelihood of a good outcome. For some patients, random fitting and repeated lens trials are not simple or secure enough. To get beyond the limits in these patient papulations discussed above, it is vital to learn the rules for selecting initial BC based on keratometry or oculyzer reading.

9. Conclusion:-

Finding this correlation would make it easier for eye care professionals to fit rigid contact lenses, reducing the need for pointless and repetitive lens fittings and speeding up the process of getting a rigid lens that fits well. Both the patients and the eye care specialist will gain from this. The association discovered in this study and the related investigations is advised to take the place of the conventional lens fitting techniques.

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