

An observational study of changes in corneal parameters following use of soft contact lens and rigid gas permeable lens



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Submitted: 07-07-2017

Revised: 25-07-2017

Published: 01-09-2017

ABSTRACT

Background: There have been significant advancements in contact lens designs and materials over the past few decades, the lenses still represent a foreign body in the ocular environment and may lead to physiological (corneal oedema or thinning) as well as mechanical (on corneal curvature) effects on the eye. As there are not many studies reporting the effect of contact lens on eyes in Indian population, this study was designed to fill the lacunae of knowledge in this context. **Aims and Objective:** To evaluate and compare the change in anterior central corneal curvature & central corneal thickness following use of soft contact lens (silicon-hydrogel) and Rigid Gas Permeable (fluoropolymer) contact lens. **Materials and Methods:** It was a Prospective, Observational, Comparative study Conducted at Venu Eye Institute & Research Centre, New Delhi. Forty eyes of 21 subjects who required contact lens were included in two groups: 20 eyes in group A (RGP contact lens users) and 20 eyes in group B (Soft contact lens users). A "baseline" parameters was measured prior to contact lens use & changes associated with contact lens wear were considered in relation to the normal baseline parameters when followed up at 3 and 6 months. **Results:** The Change in anterior central corneal curvature in both the groups was NOT statistically significant (p-value of >0.05) between pre-contact lens wear and with contact lens wear at 3 & 6 months. And, there was Significant Corneal thinning between pre-contact lens wear and with contact lens wear at 3 & 6 months in both the groups individually (p-value <0.05). However, on comparing the difference in change in CCT between both the groups was NOT statistically significant at 3 and 6 months. **Conclusions:** With contact lens use, there was no significant change in Anterior Central Corneal Curvature in Soft as well as RGP contact lens group at 3 & 6 months. Though there was significant central corneal thinning in both the groups individually at 3 & 6 months, However, on comparing the change in CCT between both the groups at 3 and 6 months was NOT significant.

Key words: Anterior central corneal curvature, Central corneal thickness, Soft contact lens, RGP contact lens

Access this article online

Website:

<http://nepjol.info/index.php/AJMS>

DOI: 10.3126/ajms.v8i5.17703

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

Contact lenses are a common method for the correction of refractive errors of the eye, but they can also be used for cosmetic and therapeutic purposes.¹ The history of development of contact lenses goes back more than 500 years, currently 125 million people worldwide are estimated to be contact lens users.² While there have

been significant advancements in contact lens designs and materials over the past few decades, the lenses still represent a foreign body in the ocular environment and may lead to physiological (corneal oedema or thinning) as well as mechanical (on corneal curvature) effects on the eye. Contact lenses can be broadly classified into: 1) Hard/rigid (non-gas permeable)-those made up of polymethylmethacrylate (PMMA). 2) Rigid gas

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permeable -those made up of cellulose acetate butyrate (CAB), silicone & fluoropolymer. 3) Soft or hydrogel -those made up of hydroxyethylmethacrylate (HEMA).³ Soft contact lens are the most common type of contact lens being used. Due to the lack of rigidity, they conform to the shape of cornea providing an increased level of comfort compared to rigid gas permeable lenses.⁴ Rigid gas permeable lenses were developed in 1970's as an alternative to PMMA contact lenses. These lenses permit increased oxygen to reach the cornea compared to PMMA contact lens by direct transmission through lens material.⁵ Though soft contact lenses are used more commonly today, RGP lenses are still widely used for general refractive power correction⁶ and for irregular and post-surgical corneas⁷ when soft contact lens are not able to sufficiently improve vision quality.

The anterior corneal surface often exhibits toricity, which may result in overall ocular astigmatism. The anterior corneal surface is generally steeper along the vertical meridian than along the horizontal meridian in young eyes.⁸ This is often referred to as "with-the-rule (WTR)" astigmatism. With age, the cornea changes its shape such that the horizontal meridian becomes steeper. This is referred to as "against-the-rule (ATR)" astigmatism.⁹ Corneal thickness is an important indicator of the metabolic status of the cornea¹⁰ and hypoxic stress induced by the contact lens determines the changes in corneal thickness with contact lens wear.¹¹ In an open eye without a contact lens, the cornea receives most of its oxygen from the atmosphere through the tear film, in addition to contribution from the aqueous humour in the anterior chamber and limbal blood vessels.¹² When a contact lens is placed on the cornea, it acts as a barrier between the cornea and atmosphere and impedes oxygen supply to the cornea resulting in hypoxic changes in the cornea.¹⁰ The ability of a contact lens to transmit oxygen to the cornea is described using two parameters: Oxygen permeability (dk) and Oxygen transmissibility (dk/t). Modulus of elasticity is a mechanical property of the contact lens material. Young's modulus of a contact lens material is a measure of its ability to retain its shape against forces such as the warping associated with the difference in contact lens base curve, corneal curvature and lid pressure. A rigid contact lens has high modulus whereas soft lens has lower modulus and therefore, conforms to the shape of the cornea.¹³

A review of the literature reveals a number of studies documenting the effect of short and long term use of contact lens with inconsistent results. The current study was designed to compare the effect of soft contact lens and Rigid Gas Permeable contact lens on changes in anterior central corneal curvature and central corneal thickness using keratometer and ultrasound Pachymeter respectively.

MATERIALS AND METHODS

This Prospective, observational, comparative study was conducted at Venu Eye Institute and Research Centre, New Delhi during the period of Jan 2015 to Nov 2016 on 40 eyes of subjects who needed contact lens for optical reasons and were motivated for regular contact lens use were selected in the study, 20 eyes in group A for Rigid Gas Permeable contact lens use and 20 eyes in group B for soft contact lens use. Normal subjects with no history of prior contact lens use or keratoconus or dry eye or active eye infection were recruited in this study.

Anterior central corneal curvature was measured with Bausch and Lomb Keratometer. CCT was performed using *Pachymetry*, Alcon OcuscanRxP Measuring system. A baseline parameters were measured prior to contact lens use. Then the subjects were being followed up at 3 and 6 months. In this way, changes associated with contact lens wear is considered in relation to the normal baseline parameters.

Statistical analysis

The quantitative variables in both groups are expressed as mean \pm SD and compared using unpaired t-test between groups and paired t-test within groups at various follow-ups. The qualitative variables are expressed as frequencies/percentages and compared using Chi-square test. A p-value < 0.05 is considered statistically significant. Statistical Package for Social Sciences (SPSS) version 16.0 is used for statistical analysis.

RESULTS

A total of 40 eyes of 21 patients were enrolled in this study, 20 eyes in each group. Mean age of participants was 18-50 years of age. Out of 20 subjects of group "A" 70% were males and 30% were females, and in group "B" 60% were males and 40% were females.

On evaluation, the anterior central corneal curvature as per the results in Table 1 and Table 2 we found that the change in anterior central corneal curvature in both the groups was NOT statistically significant (p-value of >0.05) between pre-contact lens wear and with contact lens wear at 3 and 6 months.

On evaluating the CCT as per the results in Table 3, we found that a significant decrease in CCT was noted between pre-contact lens wear and with contact lens wear of RGP lens at 3 months (P value of <0.001), and at 6 months (P value of <0.001) suggestive of corneal

thinning. In the SOFT contact lens group also, a significant decrease in CCT was noted between pre-contact lens wear and with contact lens wear at 3 months (P value of <0.001) & at 6 months (P value of <0.001) in SOFT contact lens group suggestive of corneal thinning (p-value <0.05).

However, on comparing both the groups as per the results in Table 4, the difference in change between both the groups at 3 months was NOT statistically significant (p-value 0.269). And, at 6 months was also NOT statistically significant (p-value 0.281).

Table 1: Change in KH			
Keratometry (KH) in dioptres	Baseline	3 months	6 months
RGP			
Mean±SD	46.01±2.11	45.90±2.13	45.87±2.05
p-value (vs baseline)	-	0.055	0.062
SOFT			
Mean±SD	43.75±1.57	43.74±1.57	43.71±1.59
p-value (vs baseline)	-	0.275	0.134

Table 2: Change in KV			
Keratometry (KV) in dioptres	Baseline	3 months	6 months
RGP			
Mean±SD	46.49±2.2	46.37±2.07	46.46±2.04
p-value (vs baseline)	-	0.054	0.375
SOFT			
Mean±SD	44.81±1.49	44.82±1.45	44.74±1.53
p-value (vs baseline)	-	0.426	0.099

Table 3: Change in central corneal thickness			
CCT (in microns)	Baseline	3 months	6 months
RGP			
Mean±SD	488.30±19.21	483.00±16.75	481.35±16.55
p-value (vs baseline)	-	<0.001	<0.001
SOFT			
Mean±SD	508.15±17.37	503.75±17.52	502.10±17.43
p-value (vs baseline)	-	<0.001	<0.001
p-value (RGP vs. SOFT)	<0.001	<0.001	<0.001

Table 4: Mean change in central cornea thickness between both the groups		
Change in CCT (wrt baseline)	3 months	6 months
RGP		
Mean±SD	5.30±4.66	6.95±6.13
SOFT		
Mean±SD	4.40±4.51	6.05±3.09
p-value (RGP vs. SOFT)	0.269	0.281

DISCUSSION

Contact lenses are the second most common option to correct refractive errors after spectacle lenses, are known to have some physiological (corneal oedema or thinning) as well as mechanical (on corneal curvature) effects on the eye. There have been many studies on corneal topographic changes induced by daily wear of RGP contact lens and soft contact lens and the results have been inconsistent with some studies reporting corneal steepening,¹⁴ some reporting flattening¹⁵ and others reporting no significant changes.⁵ Similarly, a number of studies documented the effect of short and long term use of contact lens on Central Corneal Thickness. As there are not many studies reporting the effect of contact lens eyes in Indian population, this study was designed to fill the lacunae of knowledge in this context. In our study, we found that change in anterior central corneal curvature in both the groups was NOT statistically significant (p-value of >0.05) between pre-contact lens wear and with contact lens wear at 3 & 6 months. Similar results were found in other studies in the past. Yebra-Pimental,¹⁶ De Rubeis MJ, Shily BG,⁵ Santodomingo-Rubido et al,¹⁷ Alba-Bueno et al¹⁸ Sanaty M and Temel A¹⁴ reported that the changes in corneal curvature that occurred in soft contact lens wearers were not statistically significant. However, in RGP group did show significant steepening in corneal curvature after 2 years of Contact lens use. It was thought that the high oxygen transmissibility and relative flexibility of soft contact lenses compared to RGP contact lenses may be the factors responsible for the change.

On the contrary, our results did not match with Harris MG et al,¹⁹ Maldonado- Codina C et al,²⁰ Gonzalez-Meijome JM et al,²¹ who found clinically appreciable changes in topographical corneal curvature. This effect seems to be a result of mechanical pressure induced by these hybrid hyper-permeable materials, characterized by a higher modulus of elasticity.

However, this study found no change in anterior central corneal curvature with contact lens use of 3 and 6 months. But, mechanical moulding effect of contact lens may cause a change in corneal curvature, as reported in previous studies.^{19,22-24} Also, these studies in which change in corneal curvature was noted, were the older ones. So, with the evolution of better contact lens materials, with reduced CL thickness and higher oxygen permeability, these changes might have become insignificant.

According to our study, there was Statistically Significant change (decrease) in CCT between pre-contact lens wear and with contact lens wear at 3 and 6 months in both the groups individually. But, on comparing the difference

in change in CCT between both the groups was NOT statistically significant at 3 and 6 months. Similar results were found in studies done by Myrowitz *et al*,²⁵ Dennis A Braun *et al*,²⁶ Liu and Pflugfelder,²⁷ Iskeleli G *et al*²⁸ and Gonzalez- Meijome JM *et al*²¹ Yeniad Bet *al*²⁹ reported that Soft contact lenses and rigid gas permeable contact lenses cause corneal thickening and corneal flattening in the first months, but they cause corneal thinning and corneal steepening with time.

Further, we did not control the timing of pachymetry measurements, which were scattered throughout the day. A diurnal variation in corneal thickness is unlikely, although it is possible that overnight swelling of the cornea from eyelid closure was a factor in our measurements.³⁰ However, Harris and coauthors³¹ report that the cornea returns to its baseline reading within 80 minutes of eye opening in those who do not wear contact lenses and within 2 hours in those who wear lenses overnight.

The specific reason for this corneal thinning has not been established. Proposed mechanisms for corneal thinning with contact lens wear include loss of keratocytes, which synthesize the collagen, glycoproteins, and proteoglycans that constitute the bulk of stromal tissue.³² Apoptosis of keratocytes may be attributed to chronic hypoxia or the release of mediators such as interleukin-1 from traumatized corneal epithelial cells.³³ It is also possible that loss of stromal tissue is caused by an accumulation of lactic acid in the cornea secondary to chronic hypoxia, resulting in the loss of mucopolysaccharide ground substance.³²⁻³⁵ Liu and Pflugfelder²⁷ proposed two other factors that may also contribute to this corneal thinning. One of those factors is increased tear osmolarity. Increased tear osmolarity has been reported to occur in subjects wearing contact lenses³⁶⁻³⁸ and chronic exposure to a hyperosmotic tear film has been reported to be capable of inducing generalized corneal thinning.³⁹

There are important ramifications of CL induced corneal thinning, in addition to this being of interest from the standpoint of understanding fundamental mechanisms of corneal physiology. Corneal thinning may be associated with a structural weakening of CL-induced corneal warpage and refractive changes. Thinner corneas have a poor acceptance to refractive surgeries. Thinner corneas may underestimate the Intra-ocular pressure, and the glaucomatous changes are more likely to go undetected.

CONCLUSIONS

With contact lens use, there was no significant change in Anterior Central Corneal Curvature in Soft as well as

RGP contact lens group at 3 & 6 months. Though there was significant central corneal thinning in both the groups individually at 3 & 6 months, However, on comparing the change in CCT between both the groups at 3 and 6 months was NOT significant.

LIMITATIONS

This study could not comment upon the fact that whether the corneal thinning is progressive or one time change. Hence, a longer follow-up is required to document the further change.

ACKNOWLEDGEMENT

I want to thank my institute, my seniors and colleagues who guided me throughout the course of this study.

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Author's contribution:

NC - Concept and design of the study, manuscript preparation, statistically analyzed and interpreted, critical revision of the manuscript; **OP** - Concept and design of the study, critical revision of manuscript and review of the study; **SM** - reviewed the literature helped in preparing first draft of manuscript collected data; **PB** - collected data, statistically analyzed and interpreted, helped in preparing first draft of manuscript.

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Source of funding: Nil, **Conflict of interest:** None.