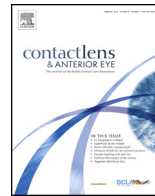




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# Change in vault during scleral lens trials assessed with anterior segment optical coherence tomography<sup>☆</sup>

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### ABSTRACT

**Purpose:** To assess the change in vault during scleral lens fitting with anterior segment optical coherence tomography (AS-OCT).

**Methods:** This study comprised of patients who had AS-OCT performed after 1 h and 4 h of scleral lens wear (PROSE, prosthetic replacement of the ocular surface ecosystem, Boston Foundation for Sight, Needham Heights, MA, USA). Vault was measured on AS-OCT as the distance between the front surface of the cornea in the center and the back surface of the scleral lens.

**Results:** Fifty eyes of 41 patients were analyzed. The main indications for scleral lens trial were ectasia (keratoconus, post surgery) (n = 20 eyes) and ocular surface disease (OSD – Stevens – Johnson syndrome, dry eyes and limbal stem cell deficiency) (n = 30 eyes). Mean age of the patients was 31.4 years. Twenty were males. The diameter of the scleral lens ranged from 16 mm to 18.5 mm. Vault measurements reduced in 45/50 eyes (90%), remained same (n = 2) or increased (n = 3). Overall mean vault decreased from  $680 \pm 421 \mu\text{m}$  at 1 h to  $589 \pm 355 \mu\text{m}$  ( $p < 0.001$ ) at 4 h of lens wear. Mean vault in ectasia was  $759 \pm 574 \mu\text{m}$  and  $634 \pm 455 \mu\text{m}$  ( $p = 0.02$ ) at 1 h and 4 h of lens wear respectively. In OSD group, mean vault was  $626 \pm 276 \mu\text{m}$  and  $558 \pm 273 \mu\text{m}$  ( $p < 0.01$ ) at 1 h and 4 h of lens wear respectively. Average reduction in the vault was  $125 \mu\text{m}$  in ectasia and  $68 \mu\text{m}$  in OSD group.

**Conclusion:** Vault reduced significantly after 4 h of lens wear during scleral lens trial indicating that the final assessment of the scleral lens may be done after 4 h of lens wear.

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## 1. Introduction

Scleral lenses, also known as haptic lenses, rest on the sclera and vault over the cornea [1] and are indicated for improving comfort or vision or both in various ocular conditions. Indications for vision improvement include patients having high irregular astigmatism such as keratoconus, pellucid marginal degeneration and post surgery [2–6]. The other indications are to improve comfort in patients having ocular surface disease (OSD) such as dry eyes, graft versus host disease and Stevens-Johnson Syndrome (SJS) [5–8]. The popularity of scleral lenses has increased in recent years with the advancement in the technology including lens materials and designs [3,9].

The scleral lens fitting is different from the conventional corneal gas permeable (GP) lenses. The selection of the first trial lenses is based on the clinician's experience and the ocular condition for which the lenses are fitted. The assessment of a scleral lens fitting includes assessment of the space between the front surface of the cornea and back surface of the lens termed the vault and the alignment of the haptic portion with the sclera. The vault is important for successful scleral lens wear as it provides the adequate tear reservoir between the lens and the cornea and avoids contact between the lens and the corneal surface. However, too much vault is not ideal as an excessively thick tear reservoir can compromise the quality of vision [10] and the oxygen transmission to the cornea [11].

The vault can be assessed either by comparing the clear space between lens and the cornea to the known lens thickness or corneal thickness or by assessing the fluorescence level of sodium fluorescein instilled underneath the lens [6,12]. However, the comparison to corneal thickness may not be ideal especially when there is associated corneal thinning as in keratoconus and the second method is subject to practitioner's judgement error.

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The scleral lenses are shown to settle on the eye after a few hours of lens wear and the time for lens settling can vary from design to design [13]. The vault and the alignment of the haptic portion with ocular surface will vary as the scleral lens settles and an accurate measurement of the vault over time is required to understand the scleral lens settling. Optical coherence tomography (OCT) is a well-known imaging method that provides the information about cornea, anterior segment, angle, contact lenses, and phakic intraocular lenses and can be used for the measurement of vault during scleral lens fitting [9,14–17]. The aim of our study is to describe the changes in the vault measured with a noncontact AS-OCT (Visante OCT, Carl Zeiss Meditec AS-OCT) after one and four hours of lens wear. The scleral lens used in the study is prosthetic replacement of ocular surface ecosystem (PROSE—Boston Foundation for Sight, Needham Heights, MA, USA).

## 2. Methods

Retrospective study of patients who had Anterior segment (AS)—OCT performed during scleral lens trial was done. IRB approved the study. AS-OCT was performed before fitting and after 1 h and 4 h of lens wear during trial. Single observer measured the vault at the center of cornea as the distance between the back surface of the lens and the front surface of the cornea using the built-in caliper tool of the instrument (Fig. 1) [15].

Fifty eyes of 41 patients were included in the study. The patient demographics, indications for scleral lens trial, scleral lens parameters, lens fitting characteristics (vault and haptic assessment) and vault measurement using OCT at 1 h and 4 h of lens wear were collected.

## 3. Results

Fifty eyes of 41 patients were studied. Twenty were males. Mean age of the patients was 31.4 years. Table 1 gives the various indications for undergoing scleral lens trial. SJS was noted in 90% (27/30) eyes in OSD group and keratoconus was noted in 80% (16/20) eyes in ectasia group.

Vault reduced in 45/50 eyes (90%), remained same in two eyes and increased in three eyes.

Overall mean vault changed from  $680 \pm 421 \mu\text{m}$  at 1 h of lens wear to  $589 \pm 355 \mu\text{m}$  at 4 h of lens wear and was statistically significant ( $p < 0.01$ ). The mean values for vault in ectasia group were  $759 \pm 574 \mu\text{m}$  (range  $-200 \mu\text{m}$ – $1830 \mu\text{m}$ ) at 1 h and  $634 \pm 455 \mu\text{m}$  (range  $-150 \mu\text{m}$ – $1730 \mu\text{m}$ ) ( $p = 0.02$ ) at 4 h of lens wear (Figs. 2 and 3). The mean vault at 1 h was  $626 \pm 276 \mu\text{m}$  (range  $-230 \mu\text{m}$ –

**Table 1**  
Indications for Scleral lens trial.

	Diagnosis	Number of eyes
Ectasia	KC <sup>a</sup>	14
	KC and VKC <sup>b</sup>	2
	Post graft	3
	Post LASIK	1
OSD	SJS <sup>c</sup>	27
	Dry eye	1
	LSCD <sup>d</sup>	2

<sup>a</sup> KC—Keratoconus.

<sup>b</sup> VKC—Vernal keratoconjunctivitis.

<sup>c</sup> SJS—Stevens–Johnson syndrome.

<sup>d</sup> LSCD—Limbic stem cell deficiency.

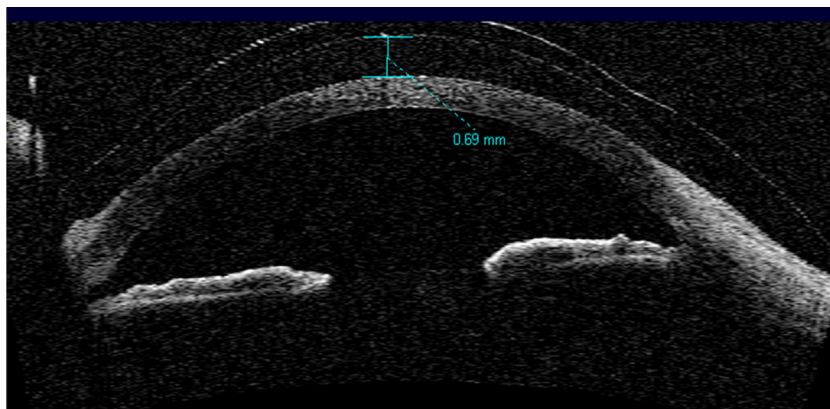
$1330 \mu\text{m}$ ) and at 4 h of lens wear was  $558 \pm 273 \mu\text{m}$  (range  $210 \mu\text{m}$ – $1200 \mu\text{m}$ ) ( $p < 0.01$ ) in OSD group (Fig. 4). The percentage reduction in vault was by 17.25% and 13.9% in patients with ectasia and OSD group respectively. Average reduction in the vault was  $125 \mu\text{m}$  in ectasia and  $68 \mu\text{m}$  in OSD group.

Scleral lens diameter ranged between 16 mm–18.5 mm: 16 mm ( $n = 1$  eye), 17 mm ( $n = 13$  eyes), 17.5 mm ( $n = 2$  eyes), 18 mm ( $n = 28$  eyes) and 18.5 mm ( $n = 6$  eyes).

Fig. 5 shows the change in vault with various lens diameters. The change in vault was more with 17 and 18 mm diameter lenses. The average percentage change in the vault measurements are as follows; 25% reduction with 16 mm diameter lens, 9.2% and 9.8% with 17 mm and 17.5 mm diameter lenses, 15.78% with 18 mm lenses and 3.75% with 18.5 mm diameter lenses. The percentage change was more with ectasia as compared to OSD with 18 mm lenses; 10.87% change in OSD group ( $n = 14$  eyes, 13 eyes reduced and one eye remained same) and vault reduced by 19% with ectasia group ( $n = 18$  eyes).

## 4. Discussion

Our study reports the changes in the scleral lens vault after 4 h of lens wear using AS-OCT in different ocular conditions compared to one hour of lens wear. Ninety percentage of the eyes fitted with scleral lenses had reduction in vault after 4 h of lens wear over one hour. The percentage reduction in vault was more in eyes with corneal ectasia (percentage reduction in vault was by 17.25%) as compared to OSD group (percentage reduction in vault was by 13.9%).



**Fig. 1.** The ASOCT shows measurement of vault from the back surface of lens and the front surface of cornea. The vault is measured after one hour of lens wear in the central area with the caliper.

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