

## A Study on Steroid Induced Glaucoma among Patients of Keratoconus Following Corneal Collagen Cross Linking

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**Conflicts of Interest:** Nil

### Abstract

**Purpose:** To determine the incidence of steroid induced glaucoma in patients with keratoconus after use of topical steroids following corneal collagen cross linking (CXL).

**Methodology:** 50 patients with progressive keratoconus who underwent Corneal collagen crosslinking were selected and patients were followed up after 1 week, 3 weeks, 6 weeks, 3months and outcome was measured in terms of visual acuity, changes in IOP, CCT, optic nerve head changes. Visual field changes and optic disc. RNFL OCT was done when necessary.

**Results:** The mean age group was 20.89 years. 42% of cases were males. The mean pre-op IOP was  $16.5 \pm 1.88$  mmhg; At 6 weeks  $17.72 \pm 2.46$ ; At 3 months  $16.99 \pm 1.58$  mm hg. 35 patients (70%) were non responders (IOP rise

of less than 5 mmhg from baseline); 13 patients (26%) were intermediate responders (IOP rise of 6-15mm of hg from baseline); 2(4%) patients were high responders (>16 mm of hg rise from baseline). Majority of the spike in IOP happened at 3 weeks.

**Conclusion** The incidence of steroid-induced IOP rise in this cohort was comparable to that of the general population. These findings suggest that while IOP monitoring is essential post-CXL, the risk of persistent steroid-induced ocular hypertension remains low.

**Keywords:** Keratoconus, IOP, Steroids, Glaucoma

### Introduction

Keratoconus is considered a bilateral and asymmetric ocular disease which results in progressive thinning and steepening of the cornea leading to irregular astigmatism and decreased visual acuity. <sup>1</sup> The etiology is still

unclear, genetic, environmental and lifestyle factors appear to be involved, factors such as atopy or rubbing of eyes are epidemiologically linked to the development of keratoconus.<sup>2</sup> Often the patient is symptom free until a relative advanced disease stage. The available options for the management of KCN are highly dependent on the stage of the disease and its progression.<sup>3</sup> If the disease is stabilized, the emphasis is given in correcting the vision. If the disease is progressing, the emphasis is to slow (arrest) the progression.<sup>3</sup> Corneal collagen cross-linking (CXL) is a minimally invasive outpatient procedure that has been shown to be effective in the arrest of the progression of KCN. [It leads to an increase of stromal rigidity, thus slowing and eventually stabilizing the progression of the keratectasia].<sup>4</sup> Topical corticosteroids are routinely prescribed in tapering dose after CXL due to their antiinflammatory action. The term "steroid responder" (SR) is used to indicate individuals that show elevated IOP after steroid use, which has been defined as IOP above 21 mmHg and/or an increase of greater than 5 to 10 mmHg compared to baseline.<sup>5</sup> Steroids are routinely used after ocular surgeries to reduce the postoperative inflammation. Among normal population, studies have shown that more than 30% of individuals show a moderate rise of IOP (6 to 15 mmHg) after topical cortisone use, while about 5% are highly responsive (IOP elevations >16 mmHg). It has been observed that there is an increased incidence of steroid induced glaucoma among patients who have undergone corneal crosslinking for keratoconus as compared to the normal population. Hence we found the need to conduct this study.

### **Objectives of the study**

To determine the incidence of steroid induced glaucoma in patients with keratoconus after use of topical steroids following corneal collagen cross linking (CXL).

### **Materials and Methods**

It was a Prospective descriptive study conducted on Patients diagnosed with keratoconus who underwent CXL. 50 patients with progressive keratoconus who underwent CXL were selected.

Patients not given consent, preexisting glaucomatous optic neuropathy, Patients diagnosed with other type of optic neuropathy, Patients diagnosed with other corneal pathologies were excluded from the study. Patients fulfilling the inclusion criteria were recruited into the study. The aims and objectives of the intended study was properly explained to the subjects and informed consent was taken.

Patient data was recorded according to the proforma. A thorough sociodemographic history including age, gender, occupation, education, income was taken. Past medical history including Diabetes, Hypertension, chronic drug usage, family history of glaucoma was taken. A detailed ophthalmological workup was done including visual acuity and BCVA using Snellen Chart, anterior segment examination using slit-lamp bio microscopy, CCT using Specular microscopy, corneal pachymetry was done using Pentacam, intraocular pressure using applanation tonometry and non-contact tonometry during first 2 weeks of post-operative period and indirect funduscopy with 20D, visual field charting using Humphrey automated perimeter, gonioscopy with Goldmann single mirror gonioscope, optic disc and RNFL evaluation by OCT was done for all patients.

Patients diagnosed with keratoconus underwent collagen cross linking as per standard treatment protocol

- Clinical manifestations of progressive keratoconus
- Pachymetry over 400 microns
- Keratometry readings less than 58 D

Post operatively patients were put on tapering dose of steroids (Prednisolone 1%) for a period of one and half month according to standard protocol.

Patients were considered to have raised IOP if IOP measured was more than 21mm of hg and considered to have glaucoma if

1. Presence of glaucomatous changes in optic nerve head
2. Thinning of retinal nerve fibre layer determined by OCT scanning
3. Presence of visual field defects

Patients were followed up after 1 week, 3 weeks, 6 weeks, 3 months and outcome was measured in terms of visual acuity, changes in IOP, CCT, optic nerve head changes. Visual field changes and optic disc. RNFL OCT was done when necessary.

### Statistical Analysis

Categorical data was represented in the form of frequency and percentage Association between variables was assessed with Chi Square Test and Fisher’s Exact test if the cell values were small.

Quantitative data was represented as Mean & Sd. Comparison between the variables was done with Unpaired t test and Paired t test for repeated measures.

A P value of <0.05 was considered statistically significant.

Table 1: Distribution of Grades of Keratoconus

Grading	No.of cases	Percentage of cases
Grade 1	22	44%
Grade 2	21	46%
Grade 3	4	8%
Grade 4	3	6%

Data was analyzed with IBM SPSS Version 28 for windows.

### Results

Mean age in the study group was 20.89 years ranging from 14-26 years. 29 cases (58%) were females and 21 (42%) cases were males. 24 (48%) cases were of right eye and 26 (52%) cases were of left eye. Majority of cases were Grade-1 and 2 keratoconus. There was no statistically significant difference in BCVA over 3 months. The mean pre-op IOP was  $16.5 \pm 1.88$  mmhg. At 1 week post-op it was  $17.50 \pm 2.18$  ; At 3 weeks it was  $18.74 \pm 2.35$ ; At 6 weeks  $17.72 \pm 2.46$ ; At 3 months  $16.99 \pm 1.58$  mm hg. There was a statistically significant increase in IOP ( $p = 0.003$ ) at 1week, peak elevation at 3 weeks ( $p = 0.000$ );and IOP returned closer to baseline levels (0.232) at 3 months. In terms of steroid responders 35 patients (70%) were non responders (IOP rise of less than 5 mmhg from baseline); 13 patients (26%) were intermediate responders (IOP rise of 6-15mm of hg from baseline); 2(4%) patients were high responders (>16 mm of hg rise from baseline). Considering increase in 5 mm of hg from baseline as spike, at 3 weeks there was a maximum of 8 patients who experienced spike of 5mm of hg from baseline. Most of these patients returned to baseline with only 2 patients having persistence of the spike. None of the patients had disc changes and visual field defect at the end of 3 months.

Table 2: Comparison of mean IOP between pre-op and follow up of 6 months period

Time Interval	IOP	
	Mean	SD
Pre OP data	16.56	1.88
1Week	17.50	2.18
3weeks	18.74	2.35
6weeks	17.72	2.46
3months	16.99	1.58

Table 3: Comparison of mean IOP between pre-op vs 1 week, 3 weeks, 6 weeks and 3 months

Time Interval	Mean	Std. Deviation	Mean difference	t Value	P Value
Pre OP IOP Vs IOP at 1 week	16.56	1.88	-0.94	-3.095	0.003
	17.50	2.18			
Pre OP IOP Vs IOP at 3 weeks	16.56	1.88	-2.18	-5.482	0.000
	18.74	2.35			
Pre OP IOP Vs IOP at 6 weeks	16.56	1.89	-1.15	-2.593	0.013
	17.72	2.46			
Pre OP IOP Vs IOP at 3 Months	16.56	1.88	-0.43	-1.210	0.232
	16.99	1.58			

Table 4: No of cases showing increase of > 5 mm of hg over 3 months follow up

Time Interval	IOP difference	
	≤ 5	> 5
Pre OP IOP Vs IOP at 1 week	47	3
Pre OP IOP Vs IOP at 3 weeks	42	8
Pre OP IOP Vs IOP at 6 weeks	44	6
Pre OP IOP Vs IOP at 3 Months	48	2

**Discussion**

Steroid-induced ocular hypertension is a critical concern for surgeons, particularly when using topical steroids. While the condition is usually reversible after stopping the steroids, steroid responders require anti-glaucoma medications to prevent glaucomatous changes. Steroids are commonly used after ocular surgeries like cataract surgery to reduce inflammation, though the steroid response in cataract patients is generally lower than in

keratoconus patients post-corneal crosslinking (CXL).

Although steroid-induced IOP rise has been reported in keratoplasty and PRK patients with keratoconus, similar reports after CXL are less common.

Keratoconus (KCN) is a progressive, bilateral corneal disease that results in thinning and irregular astigmatism, causing decreased vision. CXL has proven effective in stabilizing the disease by increasing stromal rigidity. Post-CXL, corticosteroids are prescribed for their anti-

inflammatory effects, but they can elevate IOP in some individuals, termed "steroid responders."

In our study, majority of the cases were Grade-1 and 2 keratoconus who underwent CXL for retarding the progression. In terms of steroid responsiveness, the majority of patients (70%) were non-responders, with an IOP rise of less than 5 mmHg from baseline. About 26% of patients were intermediate responders, with an IOP rise between 6-15 mmHg, while 4% were classified as high responders. This was similar to previous study where Becker et al concluded that, 66% of patients in normal population are non-responders (IOP rise  $\leq 5$  mmHg), 29% are intermediate responders (IOP rise between 6-15 mmHg) and 5% of them are high responders (IOP rise more than 15 mmHg). Maximum spike was seen at 3 weeks. The results of our study does not show an abnormally high incidence of steroid induced rise in IOP as compared to the normal population.

### Conclusion

In this study, the majority of keratoconus patients undergoing corneal crosslinking (CXL) were non-responders to steroid-induced intraocular pressure (IOP) elevation, with only a small proportion exhibiting a significant rise. A statistically significant increase in IOP was observed postoperatively, peaking at 3 weeks, but returned close to baseline by 3 months. Although a few patients experienced an IOP spike of  $\geq 5$  mmHg, most cases normalized without long-term consequences, and no glaucomatous changes were observed. The incidence of steroid-induced IOP rise in this cohort was comparable to that of the general population. These findings suggest that while IOP monitoring is essential post-CXL, the risk of persistent steroid-induced ocular hypertension remains low.

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