

Incidence of Neurotrophic Keratopathy in Association with Diode Endolaser Retinal Photocoagulation

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Abstract

Background	Neurotrophic keratopathy as a consequence of laser retinal photocoagulation is not uncommon problem but unfortunately and unfortunately it is not well evaluated in Iraq as well as the world.
Objective	To estimate the incidence of neurotrophic keratopathy in association with diode endolaser retinal photocoagulation.
Methods	This cross-sectional descriptive study was conducted in vitreoretinal clinic at Ibn-Alhaithum Teaching Eye Hospital in Baghdad. Patients were selected during a period from April 2013 to January 2014, all patients were examined by slit- lamp microscope, and condensing lens + 78 Diopter for dilated fundus examination and cotton wisp to assess corneal sensation. Positive cases documented by anterior segment photograph.
Results	The study sample consisted of 108 vitrectomized eyes of 108 patients, their ages ranged between 5-65 years old with mean of (35.5 years), 42 of them were females and 66 of them were males. By follow up of those patients; 13 of their eyes (12%) developed neurotrophic keratopathy. It had been found that 61.5% of those eyes manifested as stage II, while 30.8% presented as stage I and only 7.7% presented as stage III.
Conclusion	Diode endolaser retinal photocoagulation may be an unrecognized reason for neurotrophic keratopathy
Keywords	neurotrophic keratopathy, diode endolaser retinal photocoagulation, pars plana vitrectomy, diode laser 810 nm
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List of abbreviations: BIOM = Binocular indirect ophthalmoscope, Ca=Calcium CO₂ = Carbonic dioxide, MMPs = Matrix metalloproteinases, PPV=Pars plana vitrectomy, SDM=Sub visible diode micro pulse, Zn = Zinc

Introduction

The cornea is the principal refractive surface of the human eye and along with the sclera forms the outermost coat of the eyeball. It constitutes up to one-sixth of the entire eyeball. The corneal epithelium is derived from the surface ectoderm and the mesoderm

gives rise to Bowman's layer, stroma, Descemet's membrane and endothelium. Tear film keeps the corneal surface moist and prevents the adherence of microbes. It also has many biologically active substances such as histamines, interleukins, prostaglandins and growth factors. Some of these factors modulate corneal epithelial migration, proliferation and differentiation⁽¹⁾.

The cornea is primarily supplied by the sensory nerves derived from the ciliary nerves of the

ophthalmic branch of the trigeminal nerve. The long ciliary nerves supply the perilimbal nerve ring. Nerve fibers penetrate the cornea in the deep peripheral stroma radially and then course anteriorly forming a terminal sub epithelial plexus. Presence of corneal sensation is vital to the maintenance of the integrity of the cornea. In cases of herpes simplex, herpes zoster and diabetes, corneal sensations are diminished and this may lead to persistent epithelial defects or delayed epithelial wound healing ^(1,2).

The diode lasers emit a wavelength of 810 nm infrared in continuous wave mode. In the eye, diode laser light is absorbed only by melanin and consequently is most commonly used for retinal photocoagulation. Low scattering of this wavelength ensures good penetration of the ocular media and of edematous retina. The 810 nm wavelength also penetrates the sclera ⁽³⁾. Common clinical protocols use intra-operatively visible endpoints that cause iatrogenic chorioretinal damage. For this reason, laser therapy is normally limited to levels of disease severity for which the benefit-to-risk ratio justifies its application. The use of 810 nm diode laser in the Micro Pulse mode offers the surgeon the possibility to minimize iatrogenic retinal damage ⁽⁴⁾.

Pars plana vitrectomy (PPV)

Small instruments, inserted through the pars plana, are used to cut and remove vitreous, peel membranes, and laser photocoagulate providing treatment to various posterior segment pathologies ⁽⁵⁾.

Neurotrophic keratitis

Neurotrophic keratitis is a degenerative disease of corneal epithelium characterized by impaired healing. Absence of corneal sensitivity is the hallmark of the condition, which may end in corneal stromal melting and perforation. The causes of decreased corneal sensation are myriad and may affect sensory nerve supply from the trigeminal nucleus to the corneal nerve endings. Reduced corneal sensation renders the corneal surface prone to occult injury and

decreases reflex tearing; it also appears to decrease healing rates of corneal epithelial injuries. Vulnerability and poor healing secondary to corneal sensory denervation favor the formation of nonhealing epithelial defects that tend to ulcerate and ultimately perforate if not appropriately treated in a timely fashion ⁽⁶⁾.

Clinical stages of neurotrophic keratitis

Stage I: punctate epithelial staining with fluorescein

Stage II: Acute loss of epithelium

Stage III: Stromal lysis

This study was conducted to estimate the incidence of neurotrophic keratopathy in association with diode endolaser retinal photocoagulation.

Methods

This cross-sectional descriptive study was conducted in Ibn-Alhaithum Teaching Hospital, the Vitreoretinal Clinic, from April 2013 to January 2014. A one hundred eight sample of patients received diode laser retinal photocoagulation during pars plana vitrectomy done by three vitreoretinal surgeons. The patients who were enrolled in this study include all vitrectomized patients who were attending the vitreoretinal clinic of the three vitreoretinal surgeons.

Exclusion criteria

Patients with diabetes, corneal surgery, herpetic eye disease, chronic glaucoma medication, patients with pars plana vitrectomy but without endolaser and age above 65 years (old age group).

Collection of data

Data were collected using a pre-constructed data collection form, which was formulated for purpose of this study and it was validated by the supervisor. The data collected included:

1. Name
2. Age
3. Gender
4. History of diabetes
5. Previous corneal surgery

6. History of herpetic infection
7. History of chronic drug use (especially glaucoma medication)
8. History of contact lens use
9. Duration of operation
10. Scraping of corneal epithelium
11. Pattern of laser (localized or 360 degree)
12. Visual acuity
13. Treatment

The followings were taken from the case sheet of the patients:

Name of senior

Reference number

Date of operation

All patients were examined using slit- lamp microscope, condensing lens +78 diopter for dilated fundus examination and cotton wisp to

assess corneal sensation. Positive cases documented by anterior segment photograph.

Ethical issue

This research has been approved by scientific council of ophthalmology.

Verbal consent has been obtained from the patients.

Statistical analysis

Statistical analysis was conducted by using Excel Microsoft Office 2013.

Results

The study sample consisted of 108 vitrectomized eyes of 108 patients, their ages ranged between 5-65 years old with mean of (35.5 years), 42 of them were related to females and 66 were related to males as shown in table 1.

Table 1. Baseline characteristics of study group

Gender	Number	Percentage
Female	42	38.8
Male	66	61.2
Total	108	100

The higher incidence of neurotrophic keratopathy occurs among age group range from 25years to less than 35 years as shown in table 2.

By follow up of those patients; 13 of their eyes (12%) develops neurotrophic keratopathy as shown in figure 1.

It had been found that 61.5% of those eyes manifested as stage II, while 30.8% presented as stage I and only 7.7% presented as stage III as shown in table 3.

Table 2. The incidence of neurotrophic keratopathy among different age groups

Age (years)	Frequency	Percentage
5-14	2	15.39
15-24	1	7.69
25-34	5	38.47
35-44	2	15.39
45-54	2	15.39
55-64	1	7.69

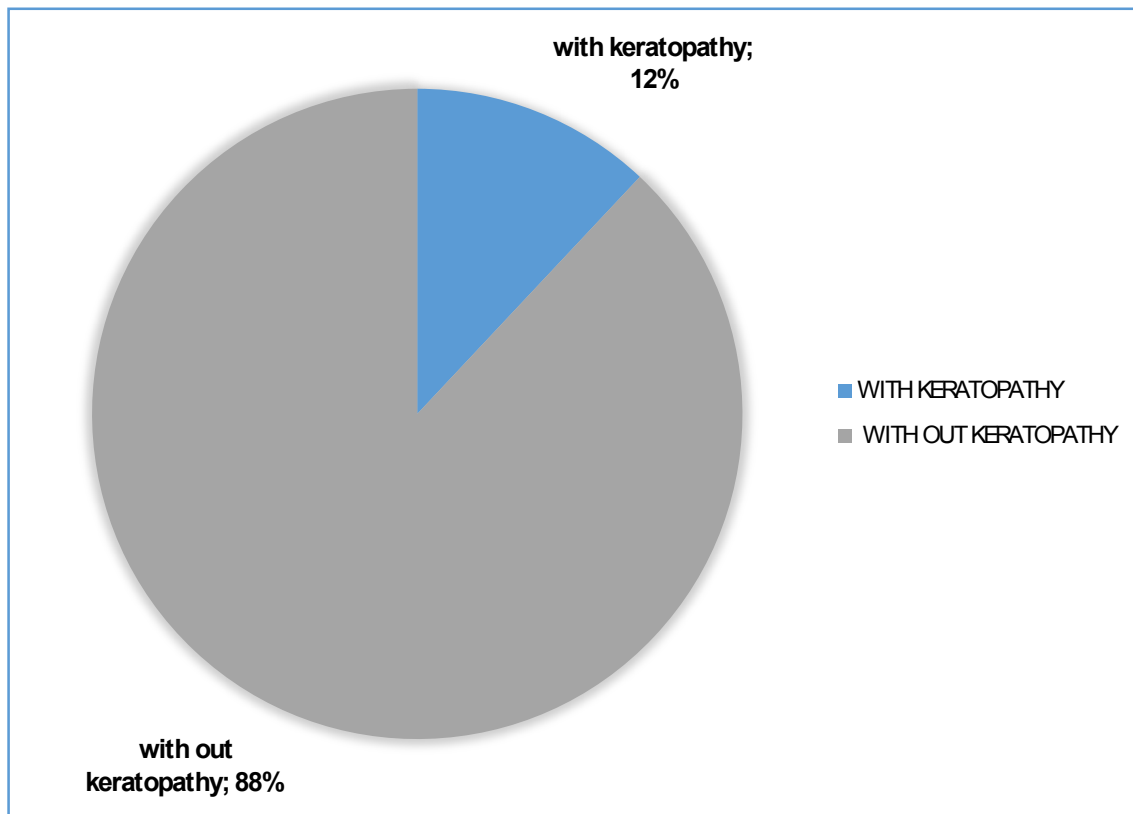


Figure 1. Incidence of neurotrophic keratopathy in association with diode endolaser retinal photocoagulation

Table 3. Frequency distribution and percentage of clinical stage

Clinical stage	Number of eyes	Percentage
Stage 1 *	4	30.8
Stage 2 **	8	61.5
Stage 3 ***	1	7.7
Total	13	100

* stage I: Punctate epithelial staining with fluorescein

** stage II: Epithelial defect

*** stage III: Stromal lysis, sometimes resulting in corneal perforation

Discussion

Neurotrophic keratitis is a degenerative disease of corneal epithelium characterized by impaired healing. Absence of corneal sensitivity is the hallmark of the condition. The causes of decreased corneal sensation are myriad and may affect sensory nerve supply from the trigeminal nucleus to the corneal nerve endings

(7). One of the iatrogenic causes of neurotrophic keratopathy is trauma to ciliary nerves by laser (1,6,8).

The diode lasers emit a wavelength of 810 nm infrared in continuous wave mode. Low scattering of this wavelength ensures good penetration of the ocular media and of edematous retina. The 810 nm wavelength also

penetrates the sclera ⁽⁴⁾. It is of high power and deeper penetration into the choroids ⁽⁹⁾. Sub visible diode micro pulse (SDM) is applied for non-damaging retinal phototherapy by using shorter bursts with small spot size (100-200 micrometer) ⁽¹⁰⁾.

In the present study, 108 patients; who had undergone pars plana vitrectomy with diode endolaser retinal photocoagulation; 13 (12%) of them developed neurotrophic keratopathy. Other causes of neurotrophic keratopathy were excluded to illustrate the association with diode endolaser retinal photocoagulation. Laser retinal photocoagulation well known to cause this condition and the diode laser specifically has physical ability to be absorbed by the fundus to somewhat unpredictable way ⁽¹⁰⁾. Diode laser pan retinal photocoagulation associated with neurotrophic keratopathy especially while using it in high power ⁽¹¹⁾.

Unfortunately, there are no studies similar to this study to compare with. Recently, two studies were published that support this study. Banerjee et al report a series of 5 cases of patients without diabetes who developed neuropathic corneal ulceration presumed secondary to long ciliary nerve compromise following vitrectomy surgery with endolaser and silicone oil tamponade for retinal detachment ⁽¹²⁾. Doyle et al found that pars plana vitrectomy with pan retinal photocoagulation may be an unrecognized cause of neurotrophic keratopathy ⁽¹³⁾.

So, the question that could be answered is that the diode endolaser retinal photocoagulation while used in continuous mode may be the cause of neurotrophic keratopathy.

The limitations of the study are:

- Small sample size
- The examination of corneal sensation was not done by esthesiometer as it is not available which is more reliable and give quantitative results.
- There was no documentation in the case sheet of all patients for epithelial scraping which is needed in some patients intraoperatively, so it can't be correlated as risk factor for neurotrophic keratopathy.

- Also the number of laser shoots and the power used not documented in the case sheets.
- Follow up period is not the same for all patients.

This study concluded that diode endolaser retinal photocoagulation may be an unrecognized reason for neurotrophic keratopathy.

The recommendations of this study are:

- Studying of a larger sample size
- Studying of two groups, one with epithelial scraping and other without.
- Studying of two groups, one treated with diode laser 810 nm and the other group should be treated with less penetrating photocoagulator laser e.g. Nd:YAG laser 530 nm.
- Also using high power density laser blamed for appearance of complications, so make sure to use as minimum as possible power density especially at 3.00 and 9.00 o'clock of the retinal periphery.
- SDM is showing promise as it is applied for non-damaging retinal phototherapy by using shorter bursts with small spot size (100-200 micrometer).
- Documentation of epithelial scraping and number of laser shoots and the power used in the case sheets.

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Author contribution

All authors have contributed equally to this article.

Conflict of interest

The authors declare no conflict of interest.

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