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# Corneal Abrasion and Visual Evoked Potentials Monitoring: Causes and Prevention

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***Authors' contributions***

*This work was carried out in collaboration between all authors. All authors participated in the writing, composing, reviewing and editing of the manuscript equally. All authors read and approved the final manuscript.*

***Review Article***

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## ABSTRACT

**Aims**: The objective of this review is to explore the methods of eye protection from corneal abrasions during general anesthesia as they relate to procedures utilizing visual evoked potentials (VEP) monitoring. Because these protective measures may lower the accuracy of the VEP equipment, we wish to establish through existing literature current effective eye protection (with a focus on Tegaderm™) and why they could potentially interfere with VEP recording.

*Keywords: Visual evoked potentials; lagopthalmos; corneal abrasion.*

## 1. INTRODUCTION

During surgical procedures, patients under general anesthesia are prone to a number of injuries due to the effects of the anesthetic or other causes. Perioperative ocular injury is a common occurrence, present in 0.17% of a 4652 patient sample population [1]. It has significant consequences to the patient and its recovery. The primary result of this type of injury is corneal abrasion and it has been commonly attributed to possibly careless technique, the friction of a mask attached to the patients face for protection or simply the result of prolonged exposure of the cornea [2]. Factors that increase the likelihood of corneal

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abrasion include procedures done in the prone or lateral positions, head or neck surgery, deliberate and sustained hypotension during surgery or in cases when patients were anemic during surgical procedure [3]. The consequences of these injuries can vary, from pain to inflammation, infection [4] and corneal abrasion, which can be detected via fluorescein staining. A number of techniques have been proposed to circumvent these complications such as the use of Vaseline gauze, usage of Tegaderm™ dressing or taping the eyes shut with adhesive tape, to take advantage of natural protective mechanisms [5].

## 2. CAUSES AND CONSEQUENCES OF INTRAOPERATIVE CORNEAL ABRASION

Corneal abrasion can be attributed to lagophthalmos in the majority of the cases observed [4]. Contributing factors for such damage include tight face masks which cause excessive periorbital pressure, restricting blood flow to the cornea resulting in insufficient oxygen levels and subsequent desquamation, leading to abrasions [6]. The exposure of the cornea is compounded by the side effect of some anesthetics that decrease tear production, which, combined with an inability to prevent evaporation of moisture, greatly increases the severity of eye drying. Animal studies have suggested that inhalational anesthetics (such as Isoflurane and Desflurane) may exert this effect [7]. Some papers illustrated the potential myotoxicity of local anesthetics to the orbicularis oculi muscle, leading to its weakness that may continue even post-operatively [8]. Attempts to physically counteract the biochemically induced lagophthalmos have varied. For example, in cases of lagophthalmos secondary to facial palsy, gold weights have been used to physically weigh down the eyelid, with greater success in younger patients whose skin retains enough elasticity to provide a significant contribution to the lid-closing effect of the weight [9].

## 3. VISUAL EVOKED POTENTIALS MONITORING CARRIES A SIGNIFICANT POTENTIAL FOR CORNEAL ABRASION

Visual evoked potentials (VEP) are used to ensure that surgical manipulation does not result in iatrogenic blindness. It is done by monitoring the electrical potentials in the occipital lobe through the scalp. A feedback to surgeons makes performance of the surgery more precised and safer. In surgical procedures performed near components of the afferent visual system, it is important to be able to monitor for the continued conduction of neural impulses, to ensure no inadvertent damage has occurred to those structures [10]. VEP recording is performed by taking the electrophysiological average of the signals recorded on the scalp with an electroencephalogram and allows diagnostic observation of the continued function and physical integrity of the visual system [11], specifically the pathway branching from the retina to the lateral geniculate to the striate cortex [12]. One standard for performing a VEP suggests use of three midline and two lateral electrodes for recording, as this increases accuracy. The patient is then subject to a strobe flash (a uniform flash of light), flashing light emitting diodes (LEDs) or a pattern stimulus (a black and white checkerboard pattern that can be steady state or transient) and then recordings are taken from the electrodes. Care must be taken to cover the eyes tested [11]. The resulting VEP is interpreted in terms of its latency and amplitude [13]. Visual evoked potentials are affected by a number of factors that cannot be controlled intraoperatively. Lubricants, Tegaderm™ dressing and tape are used to protect the eyes from negative effects of lagophthalmos when monitoring goggles are worn. LED goggles used for intraoperative monitoring utilize a red light stimulus that is transmitted through the patient's eyelids and generates a measurable response [14]. Goggles are distinctly beneficial as they provide a large stimulation field; to their detriment, however, they

prevent direct observation of the eye and stimulation occurs through the patients closed eyelid [15].

VEPs are considered to be most beneficial in cases where the patients' anterior visual pathway is in question, in patients with visual symptoms but no findings on examination or in those with a disease known to disturb the visual pathway but who failed to present symptoms [16]. Specific examples include: resection of pituitary tumors, craniopharyngioma, optic glioma, orbital pseudotumor, occipital arteriovenous malformation, meningioma impinging on the optic chiasm and chondrosarcoma of the sphenoid wing; drainage of pituitary abscess; clipping of internal carotid artery and basilar artery aneurysms; surgical correction of cerebrospinal fluid rhinorrhea and treatment of orbital fracture. VEPs are highly sensitive but are not specific. VEP cannot be used to diagnose a specific pathology [13].

By VEP continuous monitoring, surgeons can be assured that novel damage to the anterior pathway has not occurred and in cases where it has occurred, further damage is prevented [17]. This technique not only reduces the potential damage in patients at risk of ocular nerve damage (through use of the aforementioned performance feedback for surgeons), but it also allows for greater restoration of visual field loss in patients in surgery for removal of a pituitary macroadenoma [18]. VEP offers a number of unique benefits: noninvasive monitoring of waveforms, data obtained is independent of the patients level of consciousness, the short latency of the anterior pathway resists the effects of some drugs, can be performed in both intraoperative and intensive care settings and the signal can be corrected for factors known to affect its latency or amplitude, such as age, gender, temperature, or stimulus intensity [19-21].

## 4. WHAT EYE PROTECTION TECHNIQUES CAN BE USED

Monitoring visual evoked potentials carries a significant risk of corneal abrasion (such as during contact of protective goggles with the corneal surface) [22]. Review of existing literature failed to identify studies which measured the direct effect of eye protection (or other physical barriers) on VEP amplitude. Work has been done, however, to establish that a fluorescing lens can cause a "veiling glare" on the lens at a wavelength between 360 nm and 430 nm, producing adequate interference to reduce VEP amplitude [23]. The observed interference suggests other impediments during the recording process could potentially interfere with validity of the recordings. To combat the risk of corneal abrasion, a number of different techniques and tools have been employed. The major categories of devices include ointments and gels, tape or physical barriers such as masks or cushions [24], each with unique benefits as well as challenges. The major causes of corneal damage (physical abrasion and corneal drying) are both directly addressed by the functions of these protective techniques [25]. The simplest method, taping, attempts to mechanically keep the eyelid closed, thus allowing the natural mechanisms of the eyelid to keep the cornea protected. Taping alone only reduces the evaporation from the eye and cannot compensate the decreased tear production caused by anesthesia [26]. Masks and cushioning are often used as complimentary treatments to ointments or taping and attempt to prevent intraocular pressure. This aim is sometimes obfuscated by ill-fitting masks or incorrect placement of cushions, resulting in increased pressure and decreasing blood flow around the eyes. This places the cornea in a hypoxic state due to reduced choroid blood flow, edema and epithelial cell sloughing causing abrasions [11]. Protection of the cornea by means of a contact lens was observed to slow the rate at which tear production decreased [27]. There are many ointments, each with different properties and viscosities, including: antibiotic ointments, artificial tears, (Viscotears® and LacriLube®) and lubricant pomades, (Duratears®) [24]. To

determine their benefit, one study followed 4652 patients, dividing them into 2 groups: 2439 in the ointment group and the remainder in the no ointment group. Eight patients developed corneal abrasions, four in each group (0.17% in the first group and 0.18% in the latter one) [6]. Ointments are available as saline, paraffin or methylcellulose-based. Paraffin is noted for decreasing the stability of the corneas natural protective film while methylcellulose prolongs it [11]. Methylcellulose was observed to provide a dual benefit not seen in other ointments: when applied, it provides both lubricant properties as well as forming a firm glue-like substance, effectively sealing the eyes shut, with no adverse effects postoperatively [25]. Sifting and Poulton have also attempted to define the merits of different ointment classes in a study. Patients whose eyes were to be taped shut were given Lacri-Lube®, Duratears®, methylcellulose or no ointment prior to the taping. Patients with tape alone or methylcellulose and tape complained of no morbidities, while 75% of those administered Lacri-lube® and 55% of those given Duratears® experienced blurred vision [6].

One option for preventing ocular injury in a patient under general anesthetic is the wound dressing Tegaderm [Fig.1]. Due to the semi-permeable nature of the polyurethane, Tegaderm™ breathability is significant, allowing the bandage to effectively block out contaminants and irritants without interfering with the proliferation of keratinocytes beneath (when applied to the skin) and slowing healing [29]. Tegaderm™ is also a popular choice in patient populations that are positioned prone. The bandage adheres very closely upon the skin and is transparent, confounding attempts to remove it [30,31].


**Fig. 1. Tegaderm™ dressing, a specialized adhesive bandage made of polyurethane that is semi-permeable [28].**

## 5. CONCLUSION

Corneal abrasion is a common injury occurring in patients undergoing procedures involving general anesthesia with visual evoked potentials monitoring, due to decreased tear production, diminished corneal reflexes and drying of the cornea itself. The exposed cornea is the result of lagophthalmos. Many products and techniques exist to reduce the occurrence of corneal abrasion, including eyes taping, use of ointments to keep eyes hydrated and physical barriers. The success of these is high and different methods can be used in combination, such as applying ointment and covering the eye with Tegaderm™ in procedures near the optic nerve and related branches of the anterior visual pathway.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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