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## Understanding seizure risk with wide field fundus photography: Implications for screening guidelines in the era of COVID-19 and telemedicine

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### ABSTRACT

**Purpose:** To report two cases of photosensitive seizures due to fundus photography flash.

**Observations:** Two patients with seizure history present to a retina clinic for routine follow up. While obtaining imaging, these patients experienced a seizure triggered by fundus camera flash.

**Conclusions:** Fundus photography is essential and ubiquitous amongst optometry and ophthalmology practices, especially in the rising era of telemedicine in the setting of the recent COVID-19 pandemic. To our knowledge, there are no other reports in the literature of seizures triggered by fundus photography flash. However, we believe this to be an under-reported phenomenon and suggest that all eye care providers screen patients for a history of seizures or epilepsy prior to fundus photography.

### 1. Introduction

In today's rapidly evolving clinical landscape, the increasing utilization and value of wide field fundus photography cannot be understated. For example, a 2013 New Zealand survey reported that 82.6% of optometry practices had fundus photography capabilities.<sup>1</sup> In light of the COVID-19 pandemic, fundus photography's potential role as an essential screening tool for eyecare providers is unprecedented, as telemedicine with wide field fundus photography is increasingly being implemented in ophthalmology and optometry private and institutional practices. Here we present two cases reflecting the unlikely but possible risk of seizures in patients undergoing flash fundus photography. We suggest that appropriate screening for patients may be of benefit as wide field fundus photography continues to develop into a vital and ever more popular diagnostic tool.

### 2. Findings

#### 2.1. Case one

A 68-year-old woman with history of seizures on 800mg of tegretol presented for routine follow up. She had a history of pars plana vitrectomy for visually significant asteroid hyalosis, and had undergone Optos

wide field imaging (Optos, Dunfermline, United Kingdom) in the past without complication. Immediately after the initial Optos fundus photography camera flash, she felt an impending seizure starting with movements in her right arm. She received 1mg of diazepam and was cushioned in a dark room with pillows and supervision. Despite these measures, she experienced an impressive clonic seizure that lasted several minutes before resolving without sequelae.

#### 2.2. Case two

A 72-year-old gentleman presented as a new patient for evaluation of possible retinal vein occlusion. Again, immediately following Optos fundus imaging he experienced an atonic seizure with slurred speech and poor motor control. The patient did not lose consciousness, but the seizure lasted about 15 seconds before he was able to communicate. Upon recovery, he reported history of a similar seizure 30 years prior after seeing flashing lights. No medication was given, and additional imaging was deferred.

### 3. Discussion

Photic or pattern induced seizures were first described in 1885 by Gowers, who reported a girl who would seize when entering bright

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sunlight.<sup>2</sup> In the era of television, the popular children's show "Pokémon" aired an episode on December 16, 1997 that infamously caused photic induced seizures in  $\geq 560$  children in Tokyo, Japan due to a 4 second sequence of flashing red and blue screens. Large population studies conducted by the Royal Air Force and Danish Air Force suggest that the incidence of photosensitivity—paroxysmal electroencephalogram (EEG) responses to flashing lights—ranges from 0.35% to 2.4%.<sup>2</sup> More prone to photosensitive EEG responses, children have a higher incidence of photosensitivity—around 8% according to some studies.<sup>2</sup> The incidence of true photic induced seizures (versus photosensitivity) is closer to 1.1/100,000 in the overall population, but 5.7/100,000 for ages 7–19 years according to studies in Great Britain.<sup>2</sup> Risk factors for photosensitivity include younger age and female sex.

A review of photic induced seizures includes the following high-risk characteristics of photic stimuli: high-contrast, binocular exposure, diffuse light, red-colored flicker, flash cycles between 15 and 25 cycles per second. Rarely, patients will respond to single bright flashes, as in the above cases. To our knowledge, there are no peer-reviewed reports of fundus camera flashes causing seizures. The Food and Drug Administration's online adverse event reporting system has a single report of adverse reaction to the Optos fundus camera flash in a patient with history of epilepsy.<sup>3</sup> The Optos and Zeiss Clarus (Carl Zeiss AG, Oberkochen, Germany) wide field fundus camera user manuals both include an epilepsy warning that patients with epilepsy may be sensitive to flashes of light.<sup>4,5</sup> Interestingly, conventional imaging with Topcon fundus photography does not include an epilepsy warning,<sup>6</sup> highlighting the potential importance of different technologies used in image acquisition. For example, the Optos is a confocal scanning laser ophthalmoscope whereas the Zeiss Clarus is a broad line fundus imaging ophthalmoscope. The relationship between light intensity and photic-induced seizures is poorly understood; it is generally believed that the likelihood of photoconvulsive response increases with higher light intensities (Table 1).<sup>7</sup> In our experience, hundreds of thousands of fundus photographs have been taken at our practice over the past 25 years with conventional non-wide field Topcon and Zeiss cameras without a seizure instance. In contrast, the two aforementioned seizure instances occurred out of thousands of Optos photographs taken over the past five years. Although the Optos and Zeiss Clarus wide field fundus cameras include an epilepsy warning, our case series is limited in that it does not establish causality between fundus photography flash and seizures.

#### 4. Strategies to mitigate risk

Given the omnipresence of wide field photography in eyecare, we recommend screening guidelines to mitigate the risk of photic induced seizures. Screening questions should include history of seizures or epilepsy, with younger age and female proclivity to photosensitivity in mind. However, it is important to note that most patients presenting with photosensitive seizures have no prior history. In a review of video game induced seizures, 27 of 35 patients did not have a history of epilepsy.<sup>2</sup> If fundus photography is absolutely necessary in a high-risk patient, we recommend that a physician be available during imaging. Additionally, settings such as flash intensity may be manually decreased. Patients may cover the contralateral eye with their hand or with a patch to reduce binocular exposure to the flash. If patients experience a seizure after exposure to fundus camera flash, gently ease them onto the ground and turn them on their side with a soft cushion under their head. Ensure that the ground is clear and hazard free. If the patient has a tie or clothing around the neck, loosen the clothing article to make it easier for the patient to breathe. Do not try to place anything in the patient's mouth. Lastly, time the seizure. If the seizure lasts for longer than 5 minutes, call 911. After resolution of the seizure, we recommend patients consider

**Table 1**

Comparison of Zeiss Clarus and Optos wide field fundus camera flash properties.

Device	Imaging Method	Flash duration	Energy (mJ)
Zeiss Clarus	Color Myd	200 ms	3
	Non mydriatic	200 ms	1.5
	FAF	200 ms	10
Optos	Color	381 ms	1.067
	Fluorescein Angiography	381 ms	0.991
	Green autofluorescence	381 ms	0.781
	ICG	381 ms	1.696

alternative transportation if they drove themselves to the appointment.

#### 5. Conclusion

In summary, we present two patients who experienced an episode of photic-induced seizures from wide field color fundus photography. Research into the different technologies of image acquisition may reveal additional strategies to reduce risk. Given the ubiquity of wide field photography, especially amidst the rising era of telemedicine in the COVID19 pandemic, we recommend all patients undergo brief screening for history of seizures prior to exposure to the camera flash.

#### Patient consent

Consent to publish the case report was not obtained. This report does not contain any personal information that could lead to the identification of the patient.

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#### Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

#### Declaration of competing interest

The authors have no relevant financial disclosures.

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