Published in final edited form as:

Doc Ophthalmol. 2012 April ; 124(2): 161–162. doi:10.1007/s10633-012-9311-8.

Response to TASER electronic control devices and eye injuries

Rony R. Sayegh,

Department of Ophthalmology and Visual Sciences, University of Maryland School of Medicine, Baltimore, MD, USA. Department of Ophthalmology, Massachusetts Eye and Ear Infirmary, Harvard Medical School, Boston, MA, USA

Kimberly A. Madsen,

Department of Ophthalmology and Visual Sciences, University of Maryland School of Medicine, Baltimore, MD, USA

Jason D. Adler,

Department of Emergency Medicine, University of Maryland School of Medicine, Baltimore, MD, USA

Mary A. Johnson, and

Department of Ophthalmology and Visual Sciences, University of Maryland School of Medicine, Baltimore, MD, USA

Michaela K. Mathews

Department of Ophthalmology and Visual Sciences, University of Maryland School of Medicine, Baltimore, MD, USA

Michaela K. Mathews: mmath002@umaryland.edu

Dear Editor

We thank Drs. Kroll, Dawes and Heegaard for their insightful comments regarding our article [1], in particular the detailed explanation of the physics of electronic control devices (ECDs). It is true that, while a TASER device can deliver up to 50,000 volts, this surge occurs only at the initial contact between the TASER probes and the target, in order to penetrate barriers such as clothes. According to a study described by Dr. Dawes and his colleagues using the bare skin of human volunteers, the mean voltage then drops to about 600 volts, which is pulsed at 19 Hz for 5 s. During this time, the resistance drops 8% from a mean level of about 600 ohms, producing a mean current of about 1 amp [2].

Skin resistance is not a fixed value; however, it varies depending on a number of factors, including moisture content, fat content, thickness, cleanness, and even individual body chemistry. The Dawes et al. [2] study measured resistance of clean, dry skin. However, resistance decreases substantially when the skin surface is wet. In our case, the ECD barb delivered its initial pulse to the eyelid and lodged in the anterior orbit, approximating the eye. As such, a larger current—perhaps several orders of magnitude larger—may have been produced because of tearing and ecchymosis, which would both lower resistance. It is not surprising, therefore, that electrical damage to the intraocular structures from a TASER has been reported clinically before [3].

In physical terms, the eyeball is essentially a liquid-filled globe with a wall thickness of less than 1 mm. This makes it prone to electrical damage. Contrary to Dr. Kroll et al.'s statement, ocular damage has been seen after electroshock therapy (ECT) [4] and contact with electrified fences [5]. The reference they use pertains more to the postoperative safety of ECT from a surgical standpoint, with elevation of intraocular pressure and integrity of the surgical wound after electrocution [6]. Interestingly, it is difficult to evaluate the incidence of visual and psychophysical changes after ECT given the patients' limited ability to cooperate after treatment due to the effect of the electrical current on the brain neural networks.

Prolonged neural depolarization can potentially cause significant damage to the delicate neural architecture of the retina. Dr. Kroll et al. appropriately raise the possibility of reversible electroporation, the permeabilization of the cell membrane due to an applied electric field. We find these to be plausible explanations for the observed widespread electroretinographic changes as well as for the reversible loss of visual acuity to a level of 20/400. The recovery of visual acuity to near-normal levels in 2 months' time is less consistent with an etiology of kinetic damage, such as commotio retinae. To further narrow down the list of possible etiologies, the authors state correctly that burns are an extremely rare consequence of TASER ECD application, and in fact, we did not find any burns on our patient. The lack of thermal damage further supports the theory of a widespread depolarization injury to the retina caused by the ECD discharge.

The authors also recognize that the question of whether the subject truly lost consciousness or just suffered postural collapse after TASERing is marginal to the report. However, there is a distinct possibility that the subject suffered a vasovagal syncope or bradycardic episode as a result of the oculo-cardiac reflex being triggered by electric stimulation of the inferior rectus muscle. The subject also could have lost consciousness as a result of the fall on his head, which was quite hard, as evidenced by his broken nose.

All of the above notwithstanding, TASERs have overwhelming decreased mortality and morbidity of both criminals and police officers in law enforcement. Officers are trained to avoid targeting the face and head. However, in uncontrolled situations, perpetrators will occasionally be struck near the eye, and ophthalmologists need to be aware that there may be damage (possibly reversible) to the eye, caused by electrical current.

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