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TECHNICAL NOTE

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A Simple Model for Teaching Postmortem Monocular Indirect Ophthalmoscopy

ABSTRACT: Although the ophthalmoscope was invented by Hermann von Helmholtz in 1851, pathologists until recently have relied almost exclusively on ocular enucleation to identify and describe postmortem fundal abnormalities. An inexpensive but valuable tool for forensic pathologists, the postmortem monocular indirect ophthalmoscope consists of a light source attached to a headband along with a hand-held lens. This permits a wide view of the fundus after death but the technique can be challenging to master for pathology residents and forensic pathology fellows. To facilitate skill acquisition in monocular indirect ophthalmoscopy, a simple and inexpensive teaching model can be constructed from hinged, cylindrical plastic containers. An artificial pupil created in the lid and a removable color fundal image placed in the bottom of the opaque container allows the pathologist-in-training to practice the technique of monocular indirect ophthalmoscopy and correctly identify, localize, and describe fundal abnormalities such as retinal hemorrhages.

KEYWORDS: forensic science, retinal hemorrhages, teaching model, postmortem monocular indirect ophthalmoscopy, autopsy, child abuse

Postmortem examination of the fundus oculi has relied on direct ophthalmoscopy or ocular evisceration, but recently the techniques of postmortem ophthalmic endoscopy and monocular indirect ophthalmoscopy have been described (1–4). Direct ophthalmoscopy has been used in attempts to estimate postmortem interval and identify retinal abnormalities but its usefulness is hindered by postmortem corneal clouding (swelling), inherent limited field of view, an inability to view the peripheral retina, and lack of stereopsis (5). In most medical examiner/coroner jurisdictions ocular enucleation is not a standard autopsy procedure unless child abuse is suspected, thus invariably inuring observational bias when citing the prevalence of certain fundal findings (e.g., retinal hemorrhages). Postmortem endoscopic funduscopy permits viewing and documentation of retinal abnormalities; however, the equipment is costly and training necessary to gain expertise in operating the endoscopic equipment and subsequent image acquisition (2). The required equipment necessary for postmortem monocular indirect ophthalmoscopy (PMIO) is relatively inexpensive and when compared to direct ophthalmoscopy the technique is less affected by corneal clouding, lens opacity, or vitreous hemorrhage. Other advantages include a relatively large field of view, high resolution, and an ability to visualize the peripheral retina. Disadvantages include low magnification and a projected aerial image that is inverted and laterally reversed. Also, the postmortem retina near the ora serrata cannot be visualized without maximal pupillary dilation and scleral depression.

Teaching PMIO to pathology residents and forensic pathology fellows offers a number of stimulating demands for skills acquisition. Indirect ophthalmoscopy is not routinely taught in most medical schools so with the exception of ophthalmologists-in-training most residents and fellows have a limited exposure to the technique. Because the projected aerial image is inverted and laterally reversed precise descriptions or recording of fundal abnormalities can be challenging. Unlike binocular indirect ophthalmoscopy with a teaching mirror attachment, the projected monocular image cannot be viewed simultaneously by the instructor and the fellow or resident.

A simple model devised for teaching direct ophthalmoscopy can be utilized for instructing pathology residents and fellows the technique of PMIO (6). Although opaque plastic 35-mm film canisters can be used, the long axis of the cylinder is considerably greater than the axial length of the typical human globe. Therefore, as suggested by Chung et al., opaque, 1 oz. cylindrical plastic hinged canisters purchased from TAP Plastics (Portland, OR; http://tapplastics.com) serve as an artificial human globe measuring 1.58 inches (outside diameter) $\times$ 1.34 inches (height). A 9-mm hole drilled in the center of the hinged lid creates an artificial pupil (Fig. 1). Fundal images obtained from ophthalmologists or optometrists depicting hemorrhagic retinopathy or fundal

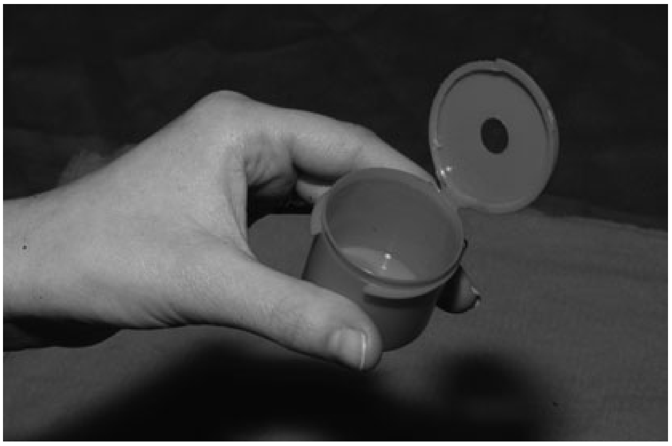

FIG. 1—*Teaching model with 9-mm hole drilled in the center of the hinged lid.*

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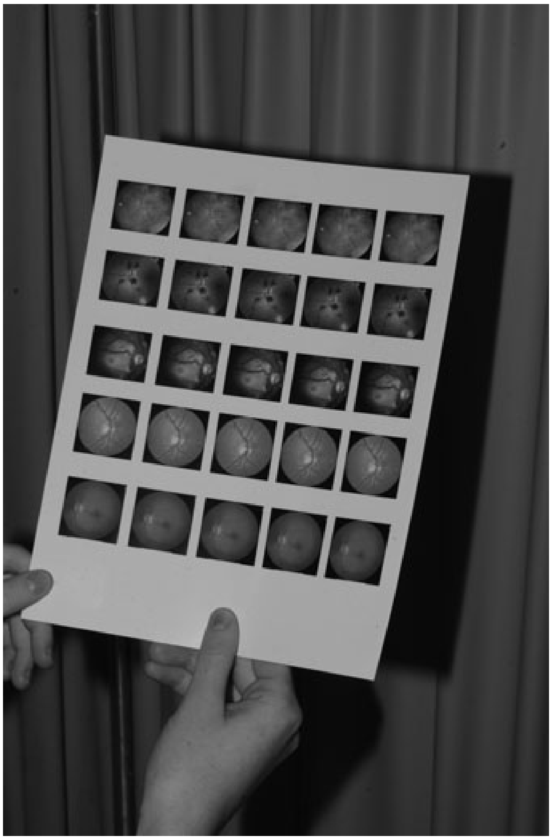

FIG. 2—*Fundal images depicting hemorrhagic retinopathy cropped and printed on photographic paper.*

FIG. 3—*With a headlamp and aspheric condensing lens, the pathologist-in-training views teaching model (labeled to indicate appropriate eye and orientation).*

abnormalities printed on matte photographic paper are cropped into 1-inch circles with available imaging software (Fig. 2). Individual images from the photographic paper are trimmed and fitted into the canister's base. The lid of the canister marked as to the appropriate eye and orientation completes the model. Using a procedural headlight and an aspheric indirect condensing lens, the pathology resident or fellow can practice viewing the simulated fundal image (Fig. 3).

Using this simple teaching model multiple fundoscopic abnormalities can be created and the pathology resident or forensic fellow can be assessed as to his/her ability to accurately identify and describe the number, location, and orientation of retinal hemorrhages and various other fundal abnormalities of pathological significance.

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