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TECHNICAL NOTE

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Postmortem Monocular Indirect Ophthalmoscopy*

ABSTRACT: Postmortem monocular indirect ophthalmoscopy permits examination of the posterior fundus and peripheral retina even if there is less than perfect anterior segment media such as postmortem corneal clouding. Light directed through the decedent's pupil from a bright focal light source illuminates the fundus and reflected light from the retina is then projected out of the eye. An aspheric condensing lens positioned in front of the eye focuses the retinal image at the focal plane of the lens. The real inverted, laterally reversed image comprises a wide field of view permitting evaluation of the decedent's fundus for retinal hemorrhages and other lesions.

KEYWORDS: forensic science, postmortem monocular indirect ophthalmoscopy, ocular fundus, retinal hemorrhages

Clinically, ophthalmologists employ a number of procedures for viewing the optic disc, macula and retina of patients, whose pupils are often pharmacologically dilated to aid fundoscopy. These methods include direct ophthalmoscopy, binocular indirect ophthalmoscopy and the use of slit lamp fundus lenses (Goldman contact lens, Hruby lens, triple mirror and condensing lenses). The direct ophthalmoscope provides a magnified monocular image of the retina and optic nerve head whilst the binocular indirect ophthalmoscope in conjunction with a hand-held condensing lens produces an inverted and laterally reversed image as does indirect slit lamp biomicroscopy with condensing lenses. The Goldman lens, central mirror of the triple mirror and the Hruby lens produce an upright, erect image, whilst the 60, 78, and 90 diopter fundoscopic lenses produce inverted images with the higher power lenses giving lower magnification. The Goldman and triple mirror lenses are applied to the surface of the eye with a coupling gel or liquid whilst the Hruby and slit lamp condensing lenses are placed in front of the eye.

Slit lamp ophthalmoscopy is not practical after death but postmortem fundal examination can be accomplished with a hand held direct ophthalmoscope, head mounted binocular indirect ophthalmoscope or by monocular indirect ophthalmoscopy. The direct ophthalmoscope provides a detailed, erect, monocular fundal image with high magnification that is dependent on the refractive error of the eye (15× in emmetropia, less in hyperopia and more in myopia) but a small field of view (about 1% of the total retinal surface). The 5–10° field of view is limited by the diameters of the decedent's and observer's pupils plus the practical working distance (1,2). Unfortunately, postmortem corneal opacity creates undesirable reflexes from the mirror action of the ocular media, particularly the cornea, that can preclude fundal examination (3). Visualization difficulty

FIG. 1—*The examiner using a surgical headlamp as a light source observes the inverted and laterally reversed image of the fundus focused by the condensing lens held at the appropriate distance in front of the decedent's eye.*

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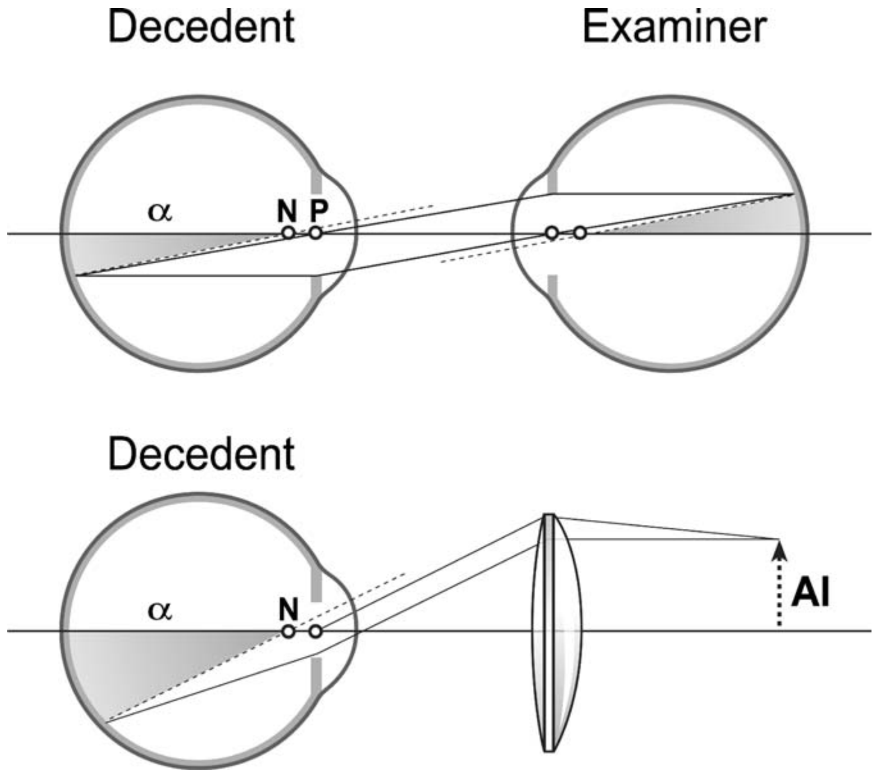

FIG. 2—*Optical diagrams demonstrating the increased field of view observed with indirect ophthalmoscopy (bottom) versus direct ophthalmoscopy (top). (N& P = nodal and axial points of the decedent's eye; α = ½ the angular extent of the visible fundus and AI = the projected aerial image of the decedent's fundus.) [Adapted and modified from Fig. 2 in Rubin ML. The optics of indirect ophthalmoscopy. Surv Ophthalmol 1964;146:449–64].*

also occurs if the decedent has other ocular media opacities such as cataract or vitreous hemorrhage.

The binocular indirect ophthalmoscope permits evaluation of the entire ocular fundus providing a low magnification, wide-angle, high-resolution view of the retina and by optically narrowing the examiner's inter-pupillary distance stereopsis is achieved. Light directed into the decedent's eye produces reflected light from the retina that can be focused to a viewable aerial image following placement of a condensing lens at its focal distance in front of the cornea. Projected between the examiner and the condensing lens the resultant real image is inverted and laterally reversed. Moderately expensive the binocular indirect ophthalmoscope is slightly cumbersome and requires some training to properly use.

Monocular indirect ophthalmoscopy utilizes a focal light source (penlight, Ears-Nose-Throat head mirror, surgical headlight, Finhoff transilluminator or light-source from a direct ophthalmoscope) and an aspheric, convex condensing lens (4–10). An excellent source of coaxial illumination a halogen or xenon surgical headlamp creates a collimated beam of bright light and permits the examiner to stabilize the condensing lens with both hands. An eyelid speculum readily retracts the decedent's eyelids and instillation of normal saline keeps the cornea moist during the examination. After dimming the room lights, the light source is held against the examiner's lateral canthus and cheek or positioned between the observer's eyes. The light source must be directed through the pupil to illuminate the fundus and establish the pupillary light reflex. In an emmetropic eye with no refractive error the retinal image projected out of the eye will be formed at infinity. Held between the thumb and index finger the condensing lens (silver rim towards the decedent's eye) is then positioned in front of the decedent's eye (initially about 1–2 cm) and then slowly pulled towards the examiner and away from the decedent's eye until the image of the fundus fills the lens (Fig. 1). The condensing lens focuses the light from the headlamp into the decedent's pupil illuminating a large part of the retina, captures light reflected from the fundus and creates the inverted, laterally reversed aerial image of the retina. Although most current condensing lenses have a multilayer anti-reflection coating to reduce unwanted reflections from the dioptric surfaces, slight adjustment of the light source may be necessary. Modern hand-held lenses for indirect ophthalmoscopy are highly corrected aspherics providing a relatively flat field and an almost aberration free image. Although the projected fundal image appears at the back of the condensing lens, the aerial image of the luminous retina is actually between the lens and examiner near the focal point of the lens. Hence the condensing lens must be positioned at the appropriate distance from the decedent's eye: a +20D condensing lens creates an image when positioned at about 5 cm and a +30 diopter lens has a focal point near 3 cm. Alignment of the condensing lens is critical since if it is close or too far from the decedent's eye the aerial fundal image will not appear or the peripheral fundus will not be illuminated. The center of the condensing lens, the decedent's pupil and the examiner's pupil must be in a straight line and perpendicular to the axis from the examiner's pupil to the decedent's pupil. Stabilization of the lens is made easier by resting the little fingers on the decedent's forehead or cheek. Repositioning the condensing lens and light source superiorly, inferiorly, nasally and temporally permits inspection of the peripheral retina. The real inverted, laterally reversed image is less magnified than that of a direct ophthalmoscope but the field of view is much larger (Fig. 2). A +15D lens will magnify 4 times, a +20D lens just over three times, a +30D just over twice and a +40 diopter lens 1.6 times. Even with the lower magnification the resolving power of indirect ophthalmoscopy is such that even small details can be observed. Factors affecting the field of view include decedent's refractive error (minimal), pupil size, refractive power and diameter of the condensing lens and distance that the condensing lens is held from the decedent's eye. The +20D and +30D lenses have a nodal angular field of view of about 45 and 55°, respectively (1,2).

A disadvantage of the technique, as with conventional direct ophthalmoscopy, can be the lack of a stereoscopic view; however, depending on the condensing lens, viewing distance and interpupillary distance of the examiner stereopsis can be facilitated (11,12). Presently available aspheric lenses range from +14 to +40 diopters and come in different diameters. Lower power lenses provide higher magnification but offer a smaller field of view and must be held farther from the decedent's eye making positioning of the lens less steady. A +14 diopter lens will give good detail of the optic nerve head whilst a +28D lens will provide a wider field of view. With a small pupil or partial corneal opacity a higher power-condensing lens such as a +30D may provide a better view than a +20 diopter lens. The smaller diameter and wider field of view of most +30D lenses facilitate ease of handling and image acquisition when first learning the technique.

Postmortem monocular indirect ophthalmoscopy permits examination of the decedent's posterior fundus and portions of the peripheral retina. The instantaneous, synoptic field of view covers more retinal topography than imaged during more tedious, less efficacious and time-consuming direct ophthalmoscopy. Even with less than perfect anterior segment media the fundus can be visualized partly because of the greater intensity of the light source used to illuminate the retina. Postmortem corneal opacity may cause the fundus to appear hazy; however, the emergent image is usually of adequate quality to readily detect lesions such as fundal hemorrhages and retinal folds.

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