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Examination of postmortem retinal folds: A non-invasive study

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ABSTRACT

The postmortem retinal fold has been previously documented, but its mechanism of formation is not known. All previous studies of the fold involved invasive techniques and the postmortem ocular fundus has yet to be non-invasively examined. Our study used the non-invasive techniques of monocular indirect ophthalmoscopy and ocular echography to examine 79 postmortem eyes of 42 bodies. We examined whether the postmortem retinal fold was associated with postmortem time, position, and/or age.

Age was significantly associated with postmortem retinal fold formation (Mann–Whitney *U* test, $P = 0.013$), which led us to examine the effect of posterior vitreous detachment (PVD) on retinal folds. The absence of a PVD was statistically associated with the presence of a retinal fold (Fisher's exact test, $P < 0.0001$). Interestingly, the presence of a PVD was also significantly correlated with retinal fold height (Mann–Whitney *U* test, $P < 0.0001$). Therefore, we hypothesized that retinal folds result from postmortem vitreoretinal traction caused by eyeball flaccidity. We also believe that the loss of retinochoroidal hydrostatic pressure plays a role.

It is important that forensic pathologists not confuse a postmortem retinal fold with traumatic retinal detachment or perimacular retinal folds caused by child abuse. When child abuse is suspected, forensic pathologists should perform enucleation and a subsequent histological examination for confirmation.

1. Introduction

The postmortem retinal fold was first described by Würdemann in 1920.[1] It was not recognized as a retinal fold back then, but described as an “opaque membrane” or “infiltration and disorganization of retina.” The next report of postmortem retinal changes was made by Kevorkian in 1961,[2] who reported changes in retinal color between 10 and 12 h after death. These changes included the retina becoming a slightly darker grey around the disk and macula.[2] It may have been that Kevorkian regarded a retinal fold as a change in retinal color.

About 40 years later, Davis et al. applied ophthalmic endoscopy to visualize the postmortem ocular fundus.[3] They reported that postmortem retina folds occurred to some degree in 125 of 200 tested eyes (62.5%).[3] This report did not discuss potential mechanisms by which retinal folds form. Ophthalmic endoscopy is an invasive examination because the eye must be punctured for camera insertion into the eye. The resulting vitreous and retinal dislocation may change the retinal fold, making this technique not ideal. Other investigators have also examined the postmortem ocular fundus by ophthalmic endoscopy,[4,5] but no mention of a postmortem retinal fold was made, perhaps because of the invasive nature of the examination. Here, we report our observations of the postmortem eye, including postmortem retinal folds investigated by the non-invasive techniques of ocular echography, indirect ophthalmoscopy, and postmortem computed tomography (PMCT). To the best of our knowledge, this is first report describing non-invasive examination of the postmortem retinal fold.

2. Materials and methods

2.1. Study subjects

We examined 144 eyes of 72 bodies that were not decomposed or burned. Cases in which the ocular fundus view was obstructed by corneal opacity or severe cataract were excluded. Eyes with pathological adhesions of the choroid and retina due to age-related macular degeneration, retinochoroidal atrophy, or photocoagulation spot were also excluded. Ultimately, 79 eyes of 42 bodies (24

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men, 18 women) met the inclusion criteria. Data were gathered during standard forensic autopsy examinations in a manner that conformed to the privacy policy on forensic autopsy, as established by the Japanese Society of Legal Medicine.[6]

2.2. Ophthalmic investigation

The first author of this report is a forensic pathologist and an ophthalmologist. Therefore, he is well-trained in both indirect ophthalmoscopy and ocular echography, both of which are routinely performed prior to autopsy at our institution. Fundus photographs were taken with a cellular phone camera in eyes with a clearly visible fundus (Fig. 1a, c), according to the method proposed by Suto et al.[7]

Ocular echography (Ultrasonic B scanner UD-8000; Tomey Corporation, Nagoya, Japan) was also used to look for a retinal fold. The probe of the UD-8000 B scanner can switch between 15 MHz, 20 MHz, and harmonic frequencies.[8] When a retinal fold was observed with ocular echography, the 20 MHz mode was used to measure retinal fold height (Fig. 1b). Ocular echography (15 MHz) was also used to confirm the presence or absence of a posterior vitreous detachment (PVD, Fig. 1d).

2.3. Computed tomography image acquisition

It is routine practice at our institute to perform a full-body postmortem computed tomography (PMCT) scan prior to autopsy (ECLOS 16-slice computed tomography [CT] scanner, Hitachi Medical Systems, Tokyo, Japan). Scan parameters were set to 120 kV and 250 mA. The helical pitch was set to 0.94, the slice thickness was set to 0.63 mm, and the reconstruction interval was set to 1.25 mm. For scans of infants, the same settings were used, with the exception of the reconstruction interval, which was set to 0.63 mm.

2.4. Statistical analyses

Differences in means and occurrence rates were tested for statistical significance using the Mann–Whitney *U* test and Fisher's exact test, respectively. Spearman's rank-order correlation analysis was used to determine the statistical significance of correlations between postmortem interval and retinal fold height. Statistical significance was defined as a P-value ≤ 0.05.

3. Results

Age ranged between 0 and 89 years, with an average age of 61.4 ± 24.6 years. The postmortem interval ranged from 4 to 48 h, with an average duration of 26.8 ± 13.1 h. We could not detect a postmortem retinal fold in any eye on PMCT. Therefore, all data presented and analyzed were obtained using ocular echography.

A retinal fold was found in 50 of 79 eyes (63.3%). Eight of these eyes were in infants, all of which had a retinal fold. Many retinal folds form around the macula and optic disc in a horizontal orientation (Fig. 1a) and appear on ocular echography as a small round shape (less than 2 mm across) with a narrow subretinal space (Fig. 1b).

3.1. Effect of postmortem characteristics on the postmortem retinal fold

We initially examined whether postmortem retinal fold characteristics were associated with postmortem interval, position, and

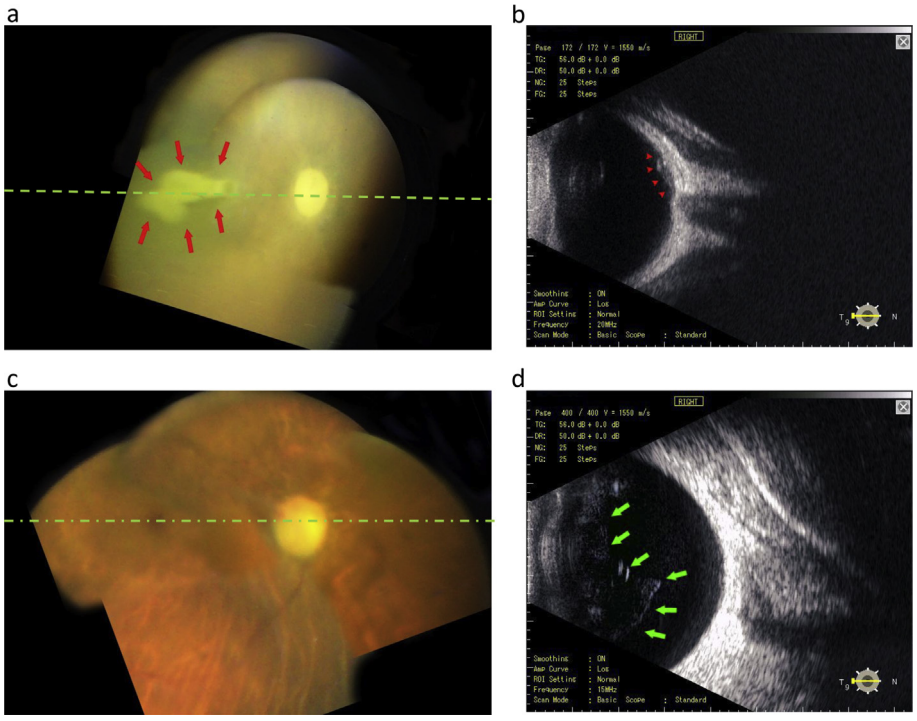

Fig. 1. a, b. A panoramic montage of fundus photographs and an ocular echography (20 MHz) image of a 2-month-old infant. The postmortem interval was approximately 9 h. The cause of death was determined to be sudden infant death syndrome. A postmortem retinal fold was observed on the fundus photograph (red arrows) and ocular echography (red arrowheads) images in the horizontal plane (green dashed line on the photographic image). c, d: A panoramic montage of fundus photographs and an ocular echography (15 MHz) image of an 86-year-old woman. The postmortem interval was approximately 12 h. The cause of death was spinal injuries. A postmortem retinal fold was not observed on either the photographic image or the ocular echography image in the horizontal plane (green dashed line on the photographic image). A complete posterior vitreous detachment (green arrows) is easily observed in the ocular echography image. (For interpretation of the references to color in this figure caption, the reader is referred to the web version of this article.)