H118 Optic Nerve Hemorrhage: A Sensitive or Specific Marker of Trauma?

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Learning Overview: After attending this presentation, attendees will: (1) better understand the optic nerve and nerve sheath anatomy, including histological differences between the Intracranial (IC) and Intraorbital (IO) components; (2) describe how to easily expose and sample the optic nerve during autopsy; (3) describe mechanisms of injury that lead to hemorrhage in one or both optic nerve compartments; and (4) determine when histological review of these components may help to elucidate the cause and manner of death in adult and pediatric autopsies.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by increasing awareness of the utility of gross and histological examination of the optic nerve as it relates to the mechanism of injury and, ultimately, the cause and manner of death.

Optic nerve evaluation is a crucial component of the pediatric autopsy when abusive head trauma is suspected. Initial studies and current literature emphasize the presence or absence of Optic Nerve Sheath Hemorrhage (ONSH)—typically subdural—as an indicator of trauma.[1] While often associated with abusive head trauma, ONSH can be seen in non-traumatic settings and thus is non-specific.[2,3] Additionally, the majority of literature on this subject does not distinguish between Subdural Hemorrhage (SDH) and Subarachnoid Hemorrhage (SAH). This pilot study examines the characteristics of Optic Nerve Hemorrhage (ONH) to better elucidate IO ONH as a sensitive and/or specific marker of trauma. The IC and IO subdural potential spaces are non-contiguous; however, the subarachnoid space is connected. This pilot, therefore, also attempts to discover the frequency of SAH extension between the IC and IO compartments and elucidate the role of Cerebrospinal Fluid (CSF) flow in the movement of SAH under traumatic and non-traumatic circumstances.

Medical examiner cases with gross evidence of SAH with and without SDH were collected over the one-month pilot portion of this ongoing study. Bilateral segments of IC optic nerve were sampled anterior to the optic chiasm. The orbits were unroofed using an autopsy saw along the medial, lateral, and anterior margins of the anterior cranial fossa followed by removal of cut bone and orbital periosteum. The exposed IO portion of the optic nerves was sampled without removal of the globe. Cases with grossly evident ocular injuries were excluded. All specimens were fixed in formalin, processed in the usual manner, and evaluated with hematoxylin and eosin. The presence or absence of gross and microscopic SDH and SAH was recorded and reviewed in conjunction with autopsy photographs and reports.

Nine cases with SAH hemorrhage were collected during the one-month period; four had concurrent SDH. Ages ranged from 16 to 84 years (median: 53; mean 45); 6 (67%) were men. The majority of cases (*n*=8; 89%) involved trauma. Causes of death included gunshot wound(s) of the head (*n*=5; 56%), multiple blunt force injuries (*n*=3; 33%), and ruptured cerebral aneurysm (*n*=1; 11%). Most traumatic cases had skull fractures (*n*=7; 78%); of those, 5 (71%) involved the orbit. Of the nine cases, only two demonstrated SAH in both the IC and the IO compartments: one trauma case with orbital fractures, and the ruptured cerebral aneurysm. No correlation between IC and IO SDH was seen.

Extension of SAH from the IC to IO compartments under non-traumatic circumstances is likely due to the high volume and arterial pressure, such as in the case of aneurysm rupture. Extension of SAH from the IC to IO compartments under traumatic circumstances is rare; primary optic nerve injury, including from abusive head trauma, is a more likely mechanism of IO ONH. These findings will be expanded upon as the study continues and incorporates a greater number of infant and pediatric cases.

Reference(s):

1. Budenz D.L., Farber M.G., Mirchandani H.G., Park H., Rorke L.B. Ocular and Optic Nerve Hemorrhages in Abused Infants With Intracranial Injuries. *Ophthalmology* 101(1994): 559-565.
2. Case, M.E. Inflicted Traumatic Brain Injury in Infants and Young Children. *Brain Pathol* 18 (2008): 571-582.
3. Case, M.E. Distinguishing Accidental From Inflicted Head Trauma at Autopsy. *Pediatr Radiol* 44(2014): S632-S640.

Forensic Neuropathology, Optic Nerve Hemorrhage, Trauma