H119 The Correlation of Pediatric Cervical Nerve Root and Dorsal Root Ganglia Hemorrhage With Hemorrhage at Other Spinal Cord Levels

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Learning Overview: After attending this presentation, attendees will be: (1) familiar with a standardized, concise methodology for evaluating and reporting Nerve Root and Dorsal Root Ganglia (NR/DRG) hemorrhage in the pediatric autopsy, and (2) knowledgeable regarding the correlation between pediatric cervical NR/DRG hemorrhage and NR/DRG hemorrhage at other spinal cord levels.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing information regarding the correlation between pediatric cervical NR/DRG hemorrhage and NR/DRG hemorrhage at other spinal cord levels, thereby assisting forensic pathologists and neuropathologists in performing and interpreting the pediatric autopsy.

Evaluation of cervical NR/DRG hemorrhage has become increasingly recognized as a crucial component of the pediatric autopsy by the forensic pathology community since an association between this hemorrhage and pediatric Traumatic Head Injury (THI) was first described in 2005.[1] Matshes et al. postulates that these hemorrhages occur secondary to forces transferred to the NR/DRG during hyperflexion-extension of the infant neck.[2] They further suggest that involvement of C3–C5 nerve roots would lead to diaphragmatic paralysis with subsequent anoxic brain injury.[2] Additional research has supported the association between cervical NR/DRG hemorrhage and pediatric THI, including studies at the Harris County Institute of Forensic Sciences (HCIFS).[3-7] As part of the comprehensive investigation of NR/DRG hemorrhage performed by the HCIFS, a comparison between cervical NR/DRG hemorrhage and NR/DRG hemorrhage at other spinal cord levels was performed.

A nine-month prospective study was conducted, as previously described.[7] All infants, 0–12 months old at time of death, autopsied by the HCIFS were included, excepting individuals with survival time greater than one week after terminal hospital admission. The spinal cord with NR/DRG at all levels was removed via modified posterior approach.[6] The tissue was fixed for two weeks in 20% formalin, then sectioned and Hematoxylin-Eosin (H&E) stained following standard methods. Each section was examined by two persons who were blinded to cause and manner of death. Hemorrhage in each NR/DRG was scored on a scale (0=no hemorrhage, 1=scant, 2=prominent).[7] The scores were standardized to facilitate direct comparison between spinal cord levels.

Over the study period, 62 cases were collected. Sixty infants from birth to 11 months (median age 3.5 months) were included in the study. One case was excluded from the study because the cause of retinal and NR/DRG hemorrhage could not be definitively attributed to (or excluded from) trauma, and one due to administrative error. Forty-nine infants died from natural, non-traumatic causes (non-trauma group) and 11 from traumatic injury (THI; undetermined or homicidal manner; trauma group). The number of NR/DRG recovered from each case varied. Cervical and thoracic sections were present in all 60 cases, lumbar in 57 cases, sacral in 55 cases, and cauda equina in 53 cases. Overall, recovery of thoracic through lumbar NR/DRG (94% and 84%, respectively) was similar to the cervical region. On average, 6 cervical, 4 thoracic, and 1 each of lumbar, sacral, and cauda equina spinal cord levels were examined in each case.

Overall, NR/DRG hemorrhage at the other four spinal cord levels showed good correlation with that of the cervical region. In the non-trauma group, 85.7% of both cervical and non-cervical NR were without hemorrhage, and hemorrhage was absent in 95.9% of cervical DRG and 91.8% of non-cervical DRG. In the trauma group, 90% of cases with cervical NR hemorrhage and 100% of cases with cervical DRG hemorrhage showed hemorrhage at the other levels. All discrepancies between cervical and non-cervical hemorrhage involved rare scores of 1 (sparse hemorrhage), with poor agreement between the two observers, consistent with previously reported data.[7] In addition, a statistically significant difference in NR/DRG hemorrhage severity between the trauma and non-trauma groups was seen at each spinal cord level ($p<0.01$), as well as the spinal cord in its entirety ($p<0.001$).

To conclude, these data suggest that forces imparted during trauma are not limited to the cervical spine but may cause significant damage to all levels of the pediatric spinal cord. If Matshes' theory linking cervical trauma and diaphragmatic paralysis is extrapolated to the non-cervical cord, many different body processes may suffer detrimental effects, including intercostal muscle dysfunction, which would further compound respiratory compromise.[2] In addition, non-cervical NR/DRG hemorrhage shows similar promise to its cervical counterpart in distinguishing traumatic and non-traumatic deaths in the pediatric population.

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Cervical Spinal Cord, Nerve Root, Dorsal Root Ganglia Hemorrhage