



G90 The Role of Microscopic Postmortem Study in Explaining Traffic-Crash Related Neck Injury: A Case Review

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After attending this presentation, attendees can expect to understand the state of the literature regarding the microscopic investigation of histopathology of traffic crash-related neck injuries.

This presentation will impact the forensic science community by discussing how the histopathologic study of traffic crash related cervical spine injuries indicate that imaging occult injury must be considered as a possible source of symptoms in patients with apparently negative plain x-ray, CT or MRI studies. The relatively high false negative rate of conventional imaging for injury to the cervical spine following traffic crash must be taken into account when a forensic medical review of such injury is conducted.

Introduction: Approximately fifty percent of occupants involved in a road traffic crash sustain a painful neck injury, ranging in severity from short lived mild discomfort to long lasting pain syndromes. Approximately ten percent of all injured patients are impaired to the point that they are disabled from their work duties. In the majority of patients objectively identifiable injury using medical imaging modalities such as x-ray, CT, and MRI are the exception rather than the norm. Since the late 1980s it has been suggested by some authors that there are crash-related spine injuries that cannot be visualized with conventional medical imaging because they are too small. Subsequent postmortem studies describing microscopic investigations of cervical spine tissue in decedents with a history of neck injury have demonstrated that such imaging occult injuries do exist. The purpose of the current review is to present a review of the literature describing histopathologic studies of the post-traumatic cervical spine.

Methods: A MEDLINE search was conducted using the Mesh terms/keywords; "Accident, Traffic", "Spine", "Autopsy", "Whiplash Injuries", and keywords; forensic imaging, imaging occult lesions, postmortem, and cervical spine. Articles describing examination of the cervical spine after fatal road traffic trauma using microscopic procedures of stained histological sections were included and retrieved articles were further crosschecked for relevant references. The included references were reviewed with regard to microscopical procedures used, microscopical findings, and diagnostic imaging procedures, to be described in a table format.

Table 1

Reference	Number subjects (N) and type of trauma	Histopathological procedures	Microscopical findings	Diagnostic imaging procedures
Pollock et al. 1982	8, trauma cases (autopsy number of 1980) neck injury and whiplash	Examination of 2mm thick slices using a dark-field microscope	Hyperemic basophil staining of the cervical discs, tearing of annular fibers, hemorrhages, calcification	None
Taylor et al. 1987	11 cases (15 cervical vertebrae included) 1 injured and 45 control	Photographs, evaluation of 2mm thick slices and microscopy of 100-µm thick	Hemorrhagic staining of the annular cartilage (MRI negative)	All cases negative on conventional radiography
Taylor et al. 1992	123 trauma cases (12 autopsies included)	Examination of 2.5-mm thick slices using a dark-field microscope	Hemorrhagic, (microscopic) staining of the annular cartilage, tearing of annular fibers, hemorrhages, calcification	Conventional radiography
Lyons et al. 1998	113 trauma cases (autopsy number of 1980) neck injury and whiplash	Examination of 2mm thick slices using a dark-field microscope, histological procedures, and electron microscopy	General and specific injury, medial and lateral annular cartilage	None
Stohler et al. 2001	11 trauma cases (autopsy number of 1980) neck injury and whiplash	Microscopy of 2mm thick slices using a dark-field microscope	Nuclear staining, hemorrhagic, specific injury, a hemorrhagic staining, spinal cord injury, ligament tears, tearing of annular fibers and basophil	Conventional radiography, MRI, CT, and ultrasound



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Year of study	Number of subjects	Method of investigation	Findings	Conclusions
1993	109	Autopsy	Injuries to the cervical spine, including vertebral body, lamina and articular facets, surrounding soft tissues (muscles, ligaments, joint capsules, and synovial folds), articular cartilage, bleeding in the joints, dorsal root ganglion injury, ventral root injury, nerve root avulsion, and injury to the intervertebral disc.	Microscopic findings were not defined clearly in all studies.
2005	119	Autopsy	Injuries to the cervical spine, including vertebral body, lamina and articular facets, surrounding soft tissues (muscles, ligaments, joint capsules, and synovial folds), articular cartilage, bleeding in the joints, dorsal root ganglion injury, ventral root injury, nerve root avulsion, and injury to the intervertebral disc.	Microscopic findings were not defined clearly in all studies.
2009	30	Autopsy	Injuries to the cervical spine, including vertebral body, lamina and articular facets, surrounding soft tissues (muscles, ligaments, joint capsules, and synovial folds), articular cartilage, bleeding in the joints, dorsal root ganglion injury, ventral root injury, nerve root avulsion, and injury to the intervertebral disc.	Microscopic findings were not defined clearly in all studies.
2009	16	Autopsy	Injuries to the cervical spine, including vertebral body, lamina and articular facets, surrounding soft tissues (muscles, ligaments, joint capsules, and synovial folds), articular cartilage, bleeding in the joints, dorsal root ganglion injury, ventral root injury, nerve root avulsion, and injury to the intervertebral disc.	Microscopic findings were not defined clearly in all studies.

* References arise from one large-scaled study

Results: Nine references were retrieved for review (Table 1). The number of subjects suffering from road traffic crash related deaths was not defined clearly in all studies. The microscopic procedures included the evaluation of 2 to 2.5-mm thick slices using a dissecting microscope, and stereomicroscopy of 3-mm thick slices to microscopy of 3 to 100- μm thick stained sections. The microscopic findings were defined in all studies and included injuries to the osseous cervical spine (vertebral body, lamina and articular facets), surrounding soft tissues (muscles, ligaments, joint capsules, and synovial folds), articular cartilage, bleeding in the joints, dorsal root ganglion injury, ventral root injury, nerve root avulsion, and injury to the intervertebral disc. Diagnostic imaging procedures were performed in five studies, including one or more of the following procedures; conventional radiology, microfocus radiography, computed tomography (CT) and magnetic resonance imaging (MRI).

Discussion: The current review of publication describing an investigation of microscopic injuries to the cervical spine of occupants subjected road traffic crashes identified nine studies for review. Discrete non-fatal injuries to the cervical spine were described in all nine studies. Injuries to the facet joints (synovial folds, articular cartilage, joint capsule, and haemarthrosis) as well as the nerve roots were particularly common. The majority of injuries could not be identified using conventional plain x-rays nor could they be found using advanced diagnostic imaging procedures such as CT and MRI. Although the research described herein did not investigate whiplash injuries *per se*, the injuries identified in these postmortem studies were non-fatal in severity and potentially painful. The presence of similar injuries in survivors from road traffic crashes of different severities seems likely. Three studies were not included in the current review, as they did not utilize microscopical procedures but relied on macroscopic examination and evaluation of photographs.¹⁰⁻¹² Even though these studies were not included, they identified very similar findings of discrete injuries to cervical spine structures and supported the finding of these being imaging occult.

Conclusions: The present review demonstrates the important role that microscopic postmortem investigation can have in elucidating traumatic pathology that is not apparent with conventional medical imaging.

References:

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- Forensic Pathology, Microscopic Lesions, Imaging Occult**