Death Under Glass: An Exhibition Highlighting Forensic Histology

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Introduction

On any given day, the evening lineup found on America's major television networks has a better than average chance of including a show involving forensic science, whether as a fictionalized story or as part of "reality television." Bemused professional death investigators have frequently noted many inaccuracies in such programming: not all murders are complex, the result of a deranged but brilliant serial killer, or solved in 42 minutes; DNA does not play a role in every case; and autopsies are not conducted under a single bare lightbulb on decedents demurely covered with a white sheet. While many facets of death investigation have been depicted on-screen, little time is devoted to a critical element of the post-mortem examination: the histological examination of human tissue.

Death Under Glass, a new exhibition of photomicrographs, offers the general public an opportunity to appreciate the arresting morphologic patterns of human tissue and to put the role of forensic histology into context. Created and curated by Marianne Hamel, MD PhD, a forensic pathologist, and Nikki Johnson, MFA, a forensic photographer, *Death Under Glass* is on display at the Mütter Museum of the College of Physicians of Philadelphia through December 16, 2014. This article introduces forensic histology and describes the current exhibition.

Forensic Histology

As death investigators ourselves, we find the lack of attention paid to forensic histology (and microscopy in general) in fictionalized portrayals of our profession to be a significant oversight. Histological analysis is among the pillars of the post-mortem examination and frequently provides information that cannot be obtained in any other manner. Forensic pathologists often rely on histology to determine the distance between a gunshot wound victim and the weapon by examining the margins of the wound under the microscope for the presence of soot. Some natural diseases are evident only through microscopic analysis: for instance, spontaneous coronary artery dissection, a not-infrequent cause of post-partum death, is easily missed if the pathologist fails to examine the histology of the coronary arteries [1]. Myocarditis, a chronic inflammation of the heart muscle that may lead to sudden death in otherwise healthy people, is a microscopic diagnosis. Although histologic analysis is not a required element of the post-mortem examination, the Forensic Autopsy Performance Standards endorsed by the National Association of Medical Examiners (NAME) states that histology is recommended in cases that are without a grossly discernable cause of death [2]. Furthermore, microscopic examination of post-mortem tissue samples can confirm or refute pre-mortem findings or bolster the diagnosis of unexpected findings found during the post-mortem examination of cases bound for litigation.

Post-mortem histology may also serve to untangle more complex aspects of a traumatic death. The crux of death investigation often rests not on the pathological findings themselves, but instead on the timing surrounding peri-mortem events. Histologic evidence of healing in cases of skeletal fractures or intracranial hemorrhages sheds light on the interval between injury and death, which is a particularly crucial piece of information in deaths from child abuse.

Materials and Methods

In years past, the only way to share the microscopic perspective of a practicing pathologist in detail and in full color was to review slides with him or her at a double-headed microscope. However, with the production of digital cameras capable of capturing high-quality images through the microscope, the public is for the first time able to see tissue with the same clarity as the death investigator. Each image featured in *Death Under Glass* is accompanied by informational panels to offer data about the tissue specimen and the pathology or cellular structures on display.

The images chosen for *Death Under Glass* were taken from post-mortem pathology slides gleaned from teaching files and personal collections of colleagues. Selected from hundreds of photomicrographs for an intersection of educational value and aesthetics, the images included in *Death Under Glass* were photographed using an Olympus BX43 microscope with UPlan Fluorite objectives fitted with an Olympus DP26 5-megapixel digital color camera and a 0.5× camera adapter.

Images depicting foreign body material embedded in the blood vessels of the lungs, deposition of amyloid protein in the kidney, and crystals in the kidney due to antifreeze toxicity were photographed under polarized light to demonstrate their unique birefringence. Enlarged photomicrographs were then printed on aluminum sheets ranging in size from 11×14 inches to 24×36 inches, thus obviating the need for framing and facilitating the transport of pieces to a new venue. Expenses associated with the exhibition *Death Under Glass* at the Mütter Museum were partially underwritten by a generous grant from Olympus Corporation of the Americas.

The Mütter Museum

Death Under Glass is currently shown in a unique and well-pedigreed venue. Founded in 1858 by Dr. Thomas Dent Mütter, the Mütter Museum of the College of Physicians of Philadelphia has long been a favorite among those who find beauty in the unusual, anomalous, and grotesque and who are fascinated with medical history. The museum houses collections of anatomical teaching preparations, wax models illustrating pathological conditions, antique medical equipment, wet tissue specimens, and a variety of other

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medical and historical esoterica. As a popular destination for tourists and local residents alike, the College of Physicians welcomed approximately 138,000 visitors last year. The museum estimates that only ten percent of visitors have a medical background. The recent renovation of the Thomson Gallery within the College of Physicians has provided a venue for several medically related art exhibitions to be shown.

Death Under Glass. Exhibitions featuring medically related artwork have recently become common, but *Death Under Glass* marks the first recent show entirely devoted to post-mortem human histology, to our knowledge. The idea, however, is not without historical precedent. Robert D. Hicks, PhD, Director of the Mütter Museum/Historical Medical Library and William Maul Measey Chair for the History of Medicine, notes in his "View from the Director" letter, "The 1876 Centennial Exhibition in Philadelphia showcased, for the first time, photomicrographs (photographs taken through a microscope) produced by U.S. Army Surgeon Joseph Janvier Woodward, made with a room-size apparatus he had built for the purpose." The late nineteenth-century hand-drawn representations of the cells of the nervous system by histologist and Nobel laureate Santiago Ramón y Cajal remain renowned for their detail and beauty despite their age. More recently, electron photomicrographs of human tissue were included in the Museum of Modern Art's 1967 *Once Invisible* show.

Anna Dhody, curator of the Mütter Museum, says the following about *Death Under Glass*: "I think the Mütter visitor will be drawn to the beauty of the images, but once in the exhibition, will be fascinated by the information about these images and what they represent. I hope *Death Under Glass* will educate the visitor about microscopy and maybe even inspire others to pursue it as a profession."

Works included in *Death Under Glass* have previously been shown in 2013 at the Walsh Gallery at Seton Hall University as part of *Cell Mates*, a collection of images inspired or derived from cellular forms. Jeanne Brasile, curator of *Cell Mates*, points out the links between abstract art and histology. "I do indeed think that there are similarities between abstraction and microscopic art. In enlarging cellular and microscopic images, patterns begin to emerge that are often appropriated or referenced in abstract art. There's an endeavor shared by artists and scientists to understand the sublime and mysterious, and this is where their interests often converge. Both artists and scientists are inspired, and obliged, to share this information with a broader audience in the course of their work." Images from *Death Under Glass* were also shown in May 2014 as part of the *You Only Die Once* show in London.

Images in *Death Under Glass*

The photomicrographs chosen for display in *Death Under Glass* depict natural disease, the results of violent and unnatural death, and benign histologic findings. A few of the images in the show are described here.

Amyloidosis is a family of diseases in which abnormal proteins, called amyloids, are deposited in human tissue and disrupt normal organ function. The cause of amyloidosis is, as yet, poorly understood. Symptoms of amyloidosis correspond to the organs most markedly affected by the disease, but can include abnormal heart function, splenic rupture, enlargement of the tongue, vomiting, and/or hemorrhage from the respiratory or gastrointestinal tract. Diagnosis results from the microscopic examination of tissue treated with a special stain known as Congo Red, which colors amyloids a distinctive pink or red hue. As the manifestations of the disease can be varied and non-specific, the diagnosis of amyloidosis is not infrequently made after post-mortem examination. Later experiments with polarized light revealed that tissue specimens with abnormal amyloid protein that were stained with Congo Red demonstrated a distinctive apple-green glow when viewed under polarized light, demonstrated in a piece titled *Birefringence* (Figure 1).

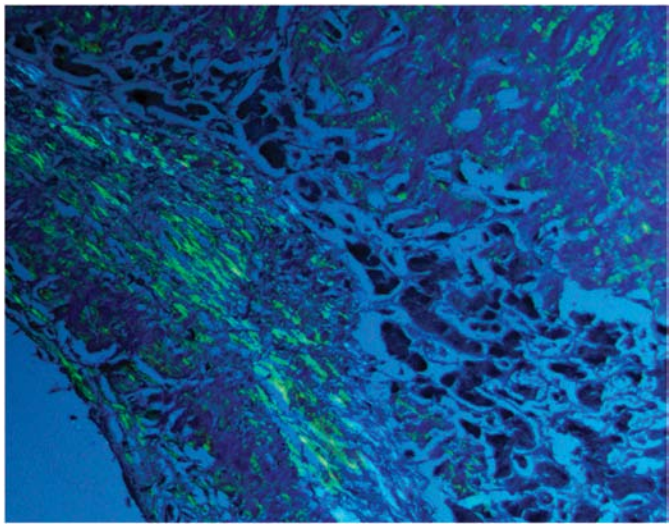

Figure 1: *Birefringence* (2014). Application of polarized light to sections of human tissue reveals the apple-green birefringence associated with amyloidosis. Horizontal field width = 290 μm.

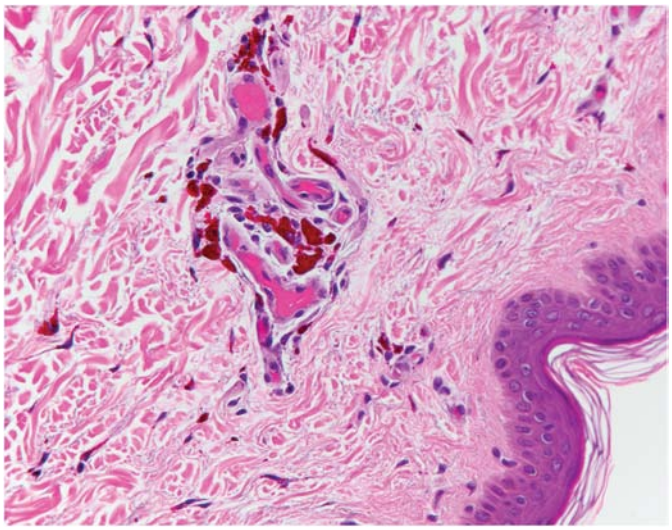

Figure 2: *Tattoo Red Pigment* (2014). Individual granules of red tattoo pigment trapped in cells within the dermis, the deeper layer of the skin. Horizontal field width = 290 μm.

Although tattoos commonly memorialize loved ones, indicate group membership, mark time behind bars, or serve as landmarks for radiation treatments, an examination of their microscopic appearance is rarely available to the public. Tattooing of human flesh is accomplished by trapping pigment granules within the dermis, the deeper layer of the skin, as seen

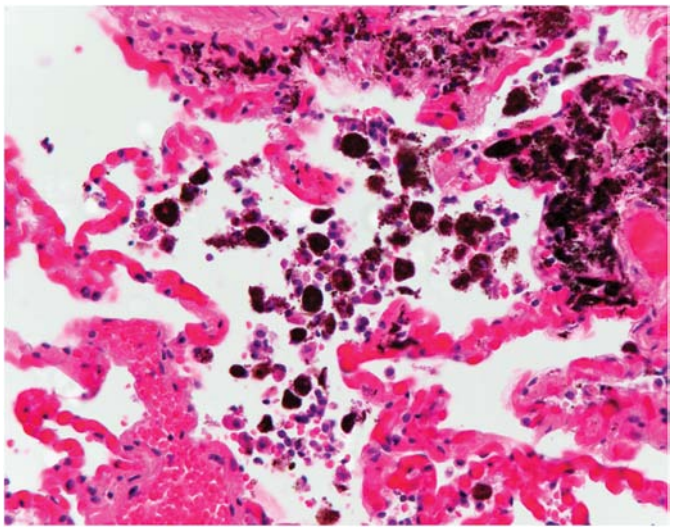

Figure 3: *Crack Lung* (2013). Cells laden with the products of combustion are the result of chronic crack cocaine use. Horizontal field width = 421 µm.

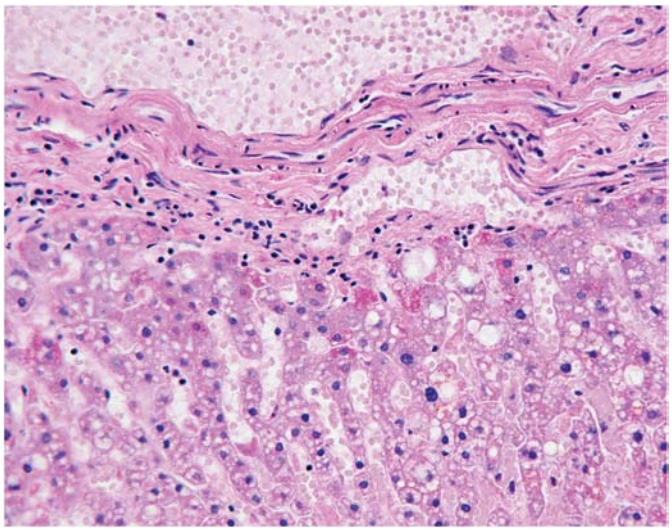

Figure 4: *Alpha 1-Antitrypsin Deficiency* (2013). Microscopic examination of tissue stained with PAS stain reveal magenta-colored alpha 1-antitrypsin particles trapped within liver cells. Horizontal field width = 421 µm.

in *Tattoo Red Pigment* (Figure 2). Macrophages and histiocytes (two types of cells found in the skin) engulf the dye after injection but are unable to completely process and dispose of it. Individual colored fragments of tattoo dye are discernable in histologic sections of skin bearing a tattoo. Death investigators may use tattoos to determine an unknown decedent's identity through comparison with pre-mortem photographs, descriptions from loved ones, or markers of membership in the military, a gang, or a social group. Tattoos are often visible even in putrefied bodies, and the skin changes associated with decomposition may serve to expose the dermis, facilitating their characterization.

"Complications of chronic substance abuse" is a phrase that appears with relative frequency on death certificates, and microscopic examination often reveals the ravages of long-term drug abuse. *Crack Lung* (Figure 3) depicts the syndrome of lung damage associated with chronic inhalation of crack cocaine. Marked by the presence of macrophages stuffed with brownish-black products of combustion within the airspaces of the lung, the microscopic findings consistent with crack lung strongly suggest a history of chronic substance abuse that may cause disability and death long after cessation of drug use.

Although autopsy findings offer little help to the decedent, the correct diagnosis of some natural diseases offers great benefit to surviving relatives. A case in point is *Alpha 1-Antitrypsin Deficiency* (Figure 4), a section of human liver stained with the periodic acid-Schiff (PAS) stain. Alpha 1-antitrypsin (AAT) deficiency is a hereditary and progressive disease that is frequently incorrectly diagnosed. Cases may come to the attention of the local medical examiner because of an unexplained and premature death. Although affected individuals produce alpha 1-antitrypsin, a protease inhibitor, mutations in the coding sequence trap the protein within liver cells, rendering them ineffective. An AAT deficiency causes early-onset pulmonary emphysema and hepatic cirrhosis. Early diagnosis and prompt intervention are the keystones of effective treatment so establishing and communicating the correct cause of death is critical for family members. The application of the (PAS) stain highlights the AAT proteins within liver cells by coloring them magenta against a light purple background.

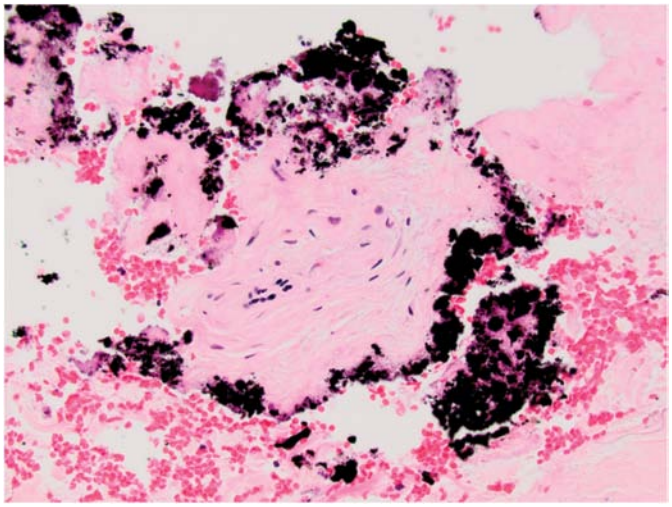

Figure 5: *Gunshot Wound* (2010). Thin sections of a gunshot entrance wound reveal the presence of soot (burned gunpowder), red blood cells due to hemorrhage, and bone fragments. Horizontal field width = 842 µm.

Determining the cause of death in cases involving violence is generally not difficult—the damage rendered by gunshot wounds or blunt trauma speaks for itself. However, histology can shed light on subtle aspects of the case, such as range of fire (the distance between the barrel of the gun and the victim). *Gunshot Wound* (Figure 5) is a microscopic section of an entrance wound. While it is well known that firing a gun discharges a bullet, it is less obvious that flame, burned gunpowder (soot), and unburned gunpowder also exit the barrel. Careful examination of the entrance wound allows a skilled pathologist to classify the entrance as a contact (in which the muzzle is pressed into the skin), near-contact, intermediate, or distant wound. Contact wounds often demonstrate thermal injuries of the wound edge and soot in the wound track, whereas near-contact wounds will deposit soot adjacent to the gunshot wound. As the distance between the end of the gun barrel and the victim increases, the likelihood increases that fragments of unburned gunpowder (called "stippling")

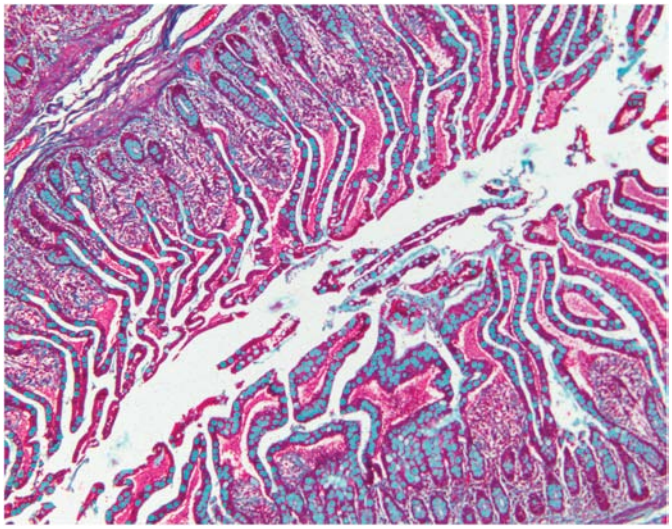

Figure 6: *Trichrome Stain of Small Bowel #2* (2013). Small bowel tissue treated with the trichrome stain differentiates structural components of tissue from one another. Horizontal field width = 842 µm.

will mark the skin surrounding the gunshot wound. However, distant gunshot wounds demonstrate no soot, stippling, or thermal injury to the edges of the wound. The blackening of skin associated with thermal injury and soot deposition can be difficult to distinguish with the naked eye, but are distinctively different under the microscope. *Gunshot Wound* shows the presence of brownish-black soot within the gunshot wound, consistent with a contact wound. Also identifiable are skin, red blood cells consistent with acute hemorrhage, and small bone fragments.

Lastly, a few images in the show were chosen simply for the dichotomy between their humble anatomical source and their striking beauty under the microscope. Among these is *Trichrome Stain of Small Bowel #7* (Figure 6), illustrating intestinal tissue treated with the commonly used trichrome stain. The trichrome stain is valued for its ability to visually contrast tissues, turning muscle and keratin red, connective tissue blue, cytoplasm pink, and nuclei black. The trichrome stain, when well applied, allows a skilled pathologist to evaluate biopsies for increased fibrosis and to determine proportions of smooth muscle and collagen in tumors.

See the Exhibition

For more information about the museum, please contact: The Mutter Museum of the College of Physicians of Philadelphia,19 South 22nd St., Philadelphia, PA 19103; (215) 563-3737; www.muttermuseum.org.

Author's note: *Death Under Glass* is dedicated to the loving memory of Elsie W. Hamel (1933–2014): wife, mother, grandmother, scholar, author, editor, gardener, chef, colleague, and friend.

References

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