The Paleopathology of the Liver*†

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ABSTRACT

Paleopathology, the study of disease in ancient remains, adds the dimension of time to our study of health and disease. The oldest finding relating the liver to disease is indirect skeletal evidence of hypervitaminosis A in an early human fossil owing to the ingestion of excessive amounts of animal liver. The earliest evidence of pathologic change in the liver is an example of schistosomal cirrhosis in a 3200 year old Egyptian mummy. Lipofuscin pigment has been identified in the liver of a 1600 year old Eskimo mummy. An experimental study suggests that the potential exists for identifying a wide range of hepatic pathology in mummified remains.

Introduction

Disease and death are integral parts of the history not only of individuals but of whole populations as well. Paleopathology is the study of the evidence of disease in ancient human and animal remains and is intended to add the dimension of time to our study of health and disease. The central lesson of paleopathology is that pathogenic organisms and the patterns of disease they cause evolve just as do larger organisms, including the hosts and vectors of disease. Paleopathologic studies have given us insight into the antiquity and evolution of congenital, traumatic, nutritional, and infectious disease, while suggesting that cancer may be a relatively recent disease.

Examination of skeletal material yields considerable paleopathologic information. As most diseases leave little or no mark on the skeleton, mummies, defined as bodies preserved either naturally or artificially, hold a much greater potential for paleopathologic examination. Postmortem examinations can be performed on mummies, and the diagnosis of many disorders can be made with relative accuracy and confidence.

Rehydration of desiccated tissues is based on immersion for several days in a solution of water, alcohol, and sodium...
carbonate, developed by the father of modern paleopathology, Sir Marc Armand Ruffer, in Egypt in 1921. The rehydrated tissue is then fixed in absolute alcohol and processed for microscopic examination in the same fashion as fresh tissue. The microscopic slides can then be stained with the standard stains of hematoxylin and eosin and a variety of specific stains. Nuclear detail is usually minimal; in general, skin and tissues of connective tissue origin are reasonably well preserved. Internal epithelial tissues and solid organs are not well preserved over long periods of time. In particular, hepatocytes would be expected to autolyze rapidly, owing to the entry of gas-producing intestinal bacteria via the portal venous system. However, the preservation of hepatic tissue in mummies has proven to be surprisingly good.

Surfeit of Liver and Hypervitaminosis A

Our oldest evidence relating the liver to disease is indirect, a probable case of hypervitaminosis A in an early human fossil owing to the ingestion of excessive amounts of animal liver. The skeleton of a Homo erectus, recovered from a site in Kenya, East Africa and dated to 1.5 million years B.P., showed periosteal bone deposition involving the long bones and skull. Thin sections prepared from the fossilized bone revealed the periosteal new bone to be coarse-woven with enlarged, randomly placed lacunae. The same gross and histologic pattern is seen in modern patients with chronic hypervitaminosis A, invariably owing to misguided self medication.

At this early stage of human evolution, meat eating had been a part of human behavior for only some 200,000 years. Early humans were in competition with carnivores, and some of these interactions might have resulted in carnivores being killed and eaten. As fire had not yet been put to use, the soft liver would have been the only easily eaten part of animal kills. Carnivore liver contains toxic levels of vitamin A, and it may well have taken some period of time before early humans learned to avoid carnivore liver.

Frozen Liver Specimens from Alaska

The oldest preserved liver comes from the desiccated body of a rabbit from the area of Fairbanks, Alaska. This specimen, retrieved in the course of early 20th century gold mining operations, is in the collection of the American Museum of Natural History and dates to 15,000 to 25,000 years B.P., on the basis of stratigraphic evidence. The mumified rabbit was dry and leather-like, with skin and hair well preserved. The viscera were easily identified on gross examination, and vegetable intestinal contents were present. Histologically, the liver showed only preservation of the fibrous framework of the portal areas. The hepatocytes were completely decomposed and replaced by masses of bacteria. No pathologic changes were identified.

Early evidence of pathologic change in the liver comes from the frozen body of an elderly Eskimo woman who died in a landslide on St. Lawrence Island, Alaska, some 1,600 years ago. Examination of her body revealed the organs to be extremely well preserved, including the liver, and established the cause of death as skull fracture and accidental inhumation, as the trachea and bronchi were packed with aspirated moss. Other findings included coronary atherosclerosis and scoliosis. Histologic examination of the liver showed preservation not only of the portal areas but also of hepatocytes, many of which contained lipofuscin pigment, consistent with her age (as determined by dental and skeletal studies) of 53 years.
Not all bodies are so well preserved by freezing. In 1981, an entire Eskimo family was found frozen in their house at Barrow, Alaska. Radiocarbon dating revealed the bodies to be 500 years old, and examination of the site and bodies made it clear that this family, two adult women and three children, had fallen victim to the springtime phenomenon the Eskimos refer to as ivu. When the ice in the Arctic Ocean begins to break up, there is the risk of wind and tides pushing the ice inland. This can occur with great speed and force, crushing everything in the ice’s path. In this case, the ivu had occurred early in the morning, as judged by the empty stomachs and dilated bladders of the victims, one of whom was found clutching her sleeping robe. Although the bodies of the children had been skeletonized, the adults, one 22 years old and the other 43 years old, were remarkably well preserved. Multiple fractured ribs and massive hemothoraces made the cause of death evident. The organs appeared to be extremely well preserved, but histologic examination of the livers was disappointing. The portal areas were preserved, but the parenchyma had been destroyed by fungal contamination, suggesting that the bodies had probably been thawed and refrozen during their 500 year burial.

**Hepatic Paleopathology in Egypt**

Paleopathology began with early 20th century studies in Egypt. Although the liver was often embalmed separately from the other organs, there have been only a few preserved liver specimens. An example is a study of a 3,000 year old mummy bundle from the West Bank of the Nile, across the river from the modern City of Luxor. The hills on the west bank contain many tombs, one of which yielded up this mummy. The body was that of a five year old child who had died of tuberculosis. On gross examination, the organs were well preserved, including the lungs, heart, liver and spleen. Histologically, the lungs showed recent and old hemorrhage, and the scoliotic vertebrae contained acid-fast bacilli. However, histologic preservation of the liver was very poor, with extensive bacterial contamination.

Far more rewarding was the study of an extremely well documented Egyptian mummy from the same general area. This mummy, part of the collection of the Royal Ontario Museum, is the body of a teen aged boy, identified by inscriptions on the coffin as Nakht, a weaver in the employ of the Pharaoh Setnakht, who died in 1198 B.C. As members of the lower class, Nakht’s family had chosen to invest in a fine coffin rather than elaborate mummification. His body had simply been desiccated and wrapped, with the viscera in place. Remarkable on gross examination was an enlarged spleen in a hemorrhagic bed, suggesting that death was due to splenic rupture. The exact pathogenetic sequence was made clear by histologic examination, which revealed calcification of the portal areas, the fine fibrous pattern of early cirrhosis (figure 1A) and *Schistosoma* ova with terminal spines (figure 1B). Similar ova were found in the intestinal lumen (along with *Taenia solium* ova) and are most likely *S. hematobium*, which has been identified in other mummies and is endemic in modern Egypt. Death was due to schistosomal cirrhosis leading to splenic enlargement and rupture.

**Experimental Study of Mummification**

The microscopic diagnosis of pathologic conditions in modern surgical and autopsy specimens often presents considerable difficulties, and these problems are immensely magnified in studying ancient remains. An approach to this matter was undertaken by an experimen-
Figure 1. A fine fibrous band, consistent with early cirrhosis, is seen extending from a calcified portal area in the liver of an Egyptian mummy (40×). B. An ovum of Schistosoma hematobium, with its characteristic terminal spine, is seen in the portal area (1,000×).

tal study, in which tissue specimens from cadavers undergoing post-mortem examination were desiccated, rehydrated, and examined histologically. The specimens were dried in an oven at 40° for two weeks, rehydrated in Ruffer’s solution, fixed in alcohol, embedded in paraffin, and sectioned and stained by standard histologic techniques. Fresh tissue sections were used as controls.

A variety of tissues and disease processes were studied by this technique. Conditions such as fatty change and cirrhosis were easily identified after undergoing desiccation and rehydration. Figures 2 show a section of liver with metastatic colon carcinoma. Figure 2A is the fresh control, while figure 2B, the mummified and rehydrated tissue, shows the hyperchromatic, pleomorphic nuclei of the tumor to be remarkably well preserved, in fact, better than those of the hepatocytes.

Conclusion

Connective tissues and their products are known to be well preserved in mummified remains, and, as expected, fatty change of the liver and cirrhosis remained easily diagnosable after the experimental mummification and rehydration process. The preservation of these lesions in the experimental setting is encouraging for future paleopathologic studies. In this review, several well preserved ancient liver specimens have been presented, with preservation of
lipofuscin pigment, cirrhosis, and parasitic infection. It is believed that the hepatic evidence of the misfortunes of ancient humans will continue to be evident in their mummified remains, should fortune smile and provide us with appropriate specimens.

References


