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EDITOR'S PAGE

Medical Imaging: The New Rosetta Stone

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An ancient Egyptian stele on a piece of igneous rock in Memphis, Egypt in 196 BCE was the key to resolving some of the mysteries of people living 20 to 50 centuries ago. *La Pierre de Rosette* or the *Rosetta stone* is thus colloquially considered to be that missing but vital clue that cracked open an unexplored fount of knowledge. Sophisticated imaging today, with its singular ability for resolving anatomy in a nondestructive manner, can act like a modern equivalent to the Rosetta stone in paleobiology and paleopathology. The paper in this issue of *iJACC* by Allam et al. (1) may be further evidence that *imaging* may indeed be a Rosetta stone in paleomedicine, unraveling mysteries of disease among ancient people and civilizations. While both the descriptions of cardiovascular disease in ancient Egyptians (2) as well as use of sophisticated computed tomographic (CT) imaging to identify pathology (3) is not new, the current paper (1) is intriguing because it is the first effort that looks systematically at vascular atherosclerosis in a large population of mummies. It also provides data that coronary atherosclerosis is more ancient than previously recorded (. . .or thought), dating it further back by 4 to 500 years, to 1550 BCE. Studying 52 selected mummies from an Egyptian collection with CT scans for evaluating vascular calcification, this study found that over one-third had evidence of vascular calcification, a common surrogate for atheroma, and 4% of the subjects had distinct coronary calcification—a remarkable finding in a body that was studied 35 centuries later.

A curiosity about the life and times of our distant ancestors has remained a powerful and emotional connection among all races. In fact, the act of mummification and leaving the body with all the accoutrements of its life was thought of as a way to maintain some connection, however tenuous, with the past (4). Yet the ability to find out details about ancestral civilizations has remained difficult and highly dependent on tools available for accurate study. Even though the power of medical imaging (the use of X-ray in 1896, just a few months after Roentgen published his invention in 1895) was recognized long ago, its use and value remained rather infantile until the advent of CT imaging (3). More powerful and accurate scanning, now possible with better CT and magnetic resonance (MR) imaging, opens up exciting avenues for intense exploration.

Medicine and Mummification in Ancient Egypt

While some descriptions extol the ability of ancient Egyptian physicians, they were, as expected with their time in antiquity, restricted in their knowledge of physiology, disease, and scientific treatments. The physicians were priests and the practice was restricted based on their holy book; off label practice or death as a result of such unorthodox treatments invited a death penalty for the physician (5)! Physicians, thus, would not have been expected to be successful in curing cardiovascular disease or be brave in even attempting novel ideas for cures. There is no good evidence that circulation was well understood even though they were aware of a connection between the heart and the pulse—*the heart speaks through the "pulse in the" extremities* (6). The heart (called *ab*) itself was considered to have a *metaphysical charac-*

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ter and be connected to the *afterlife* (7). During the process of mummification, all internal organs, including the heart, were removed for repackaging suitable for afterlife. A stone scarab, often shaped like a heart and inscribed with protective incantations, was placed into the thorax; this had implications for afterlife similar to themes found elsewhere such as, *I will take the stony heart out of their flesh, and give them a heart of flesh* (Ezekiel XI, King James Bible). Unfortunately, despite centuries of this practice of taking out the organs, there is really no good description available of cardiac pathology, implications for cause of death, or any description of atherosclerosis. On the contrary, this dismantling of the heart and adjacent blood vessels restricts the ability to use modern imaging for cardiac atheroma and other pathology. Heart scarabs start appearing approximately around 1700 BCE and became widespread in the late second Intermediate and the New Kingdom period (1550 to 1070 BCE). It was fortuitous that the Allam et al. (1), whose subject material was largely from around and after this period, found a heart or remnants of cardiac tissue in 60% of their subjects and thus had a good sample size to work with.

Occurrence of Atheroma

Is there a reason to believe that the ancient Egyptians would have a different amount of atheroma than present day populations? Although the occurrence of atheroma has been well described in Egyptian mummies (2), the novelty of the present investigation is in the use of modern imaging technology to evaluate pathology in a nondestructive way. What is most intriguing is the occurrence of atheroma at a considerably young age in ancient Egyptians. Although the evidence is scanty, a high fat diet and lack of exercise among the privileged has been thought to account for this (8). Skeletal X-rays have showed a high incidence of dental infections and even though the people as a whole had adopted reasonable hygienic practices (5), local and systemic infections were rampant. Inflammation associated with this kind of environment could play a part in atherosclerotic disease process. It is also unclear how much of a role stress might have played. Predynastic life was probably harshest with more injuries compared to the later dynastic period (9). Even within the dynastic period, it is estimated that about one-half of the young population was gone by 30 years-of-age suggesting a difficult life. In the current paper (1), all of the subjects were from the middle kingdom or later and there was no difference in the occurrence of atheroma between the early and later time periods. Some speculative genetic connections are also possible. While not entirely reliable, a few anthropometric studies have linked ancient Egyptian populations, especially the pre-dynastic people, to those in Northern India even more than the closely located Ashanti or Lachish populations (10). It is interesting to conceive that the high genetic susceptibility to diabetes and atherosclerotic disease, especially with a high fat diet, seen in the North Indian population (11) could have been shared with those bearing Egyptian ancestry. Further studies combining information from large mummy deoxyribonucleic acid and tissue banks with anthropometric and imaging information might shed more light on these connections.

Limitations of Such Data

A fair amount of bias is inherent in dealing with such data and scientists can only work on the material they have access to, therefore, a lot of caution is needed when making sweeping generalizations from these data. A necropolis is most assuredly not a good sampling of the underlying population, especially over centuries of desecration and looting. Mummification originated around 2600 BCE (before availability of a significant number of mummies in any study published so far) and continued until about 5 BCE. The available bodies are but a fraction of the many preserved. Thousands were destroyed for various reasons including thievery, quackery, and inexpensive entertainment. What is found today is thus largely a matter of chance, the ability to survive gravediggers, and the efforts of a few brave individuals to preserve ancient artifacts. Other factors that may introduce a subtle selection bias include the method of preservation and the effect of harsh preservation techniques and solvents like Natron. Further, only the rich could afford mummification which introduces bias about dietary practices, exercise habits, and general well being (8). Mummification extended into the less privileged middle classes in later times, but the mummification methods and organ removal was more destructive (12). Not surprisingly, the average age of subjects with atheroma was much higher than those without atheroma. However, the mean age of this group was far higher than the expected mean age of death in those times; average life span was about 36 years in the dynastic period and even less in the pre-dynastic populations (9). Finally, due to the antiquity of the subjects, there are gaps in the data published about mummies in literature with an uncertainty about the age/timelines (13). Causes of death are often unclear and it is not known if the atheroma had clinical significance during life, or was the proximate cause. Throughout history, disease among the leadership has been speculated to have affected the destiny of empires and the course of history: for example as Zola wrote famously "Un gravier dans la chair d'un homme [gravel in the flesh of a man]" concerning Napoleon III "et les empires s'écroulent [crumbling empires]" influenced the destiny of the French Empire. Even though the arterial gravel (calcium) affected the nobility in Egypt, it is not clear from historical records that this may have altered history in a material way; interestingly, one of the mummies in a different study afflicted with gravel in the artery was believed to be the Pharaoh at the time of the Exodus. It is tempting to think that mummies from other regions that have been naturally preserved (frozen) could provide information wherein internal viscera were not repositioned (14) and amenable to MR imaging (15).

Ethics of Investigating Mummies

While this inquiry into antiquity and its nondestructive nature is very attractive, it has also raised questions (16,17) about propriety (due to a lack of informed consent), privacy (possibility of desecrating the secrets of the dead), and provenance (who has the right to the bodies, their information, and the right to decide what is appropriate research). Unlike in the past where such research was a spectacle that sometimes (12) even bordered on the bizarre (e.g., Augustus Granville used body fat from the Irtyersenu mummy to make candles that provided ambience for the famous public autopsy). There is a general sense now that such investigation should be thoughtful and as minimally intrusive as possible (16,17). Imaging techniques, as is obvious, fit this bill perfectly. Just as a plutonic intrusive igneous rock provided information about the composition of the mantle, and an ancient inscription on a piece of such rock provided information about an ancient civilization, a calcium density on a CT scan now provides information about the mantle of atherosclerosis in ancient arteries. The Rosetta stone was beset with war, territorial and scientific rivalries, plagiarism, false interpretations, and assertions suited to each side's view of history. While CT is now at the forefront of mummy imaging, MR imaging and other methods are starting to find a role (18,19). Hopefully, such a fate does not befall various imaging modalities as they jockey to be the torchbearers of paleobiology and paleopathology.

The study by Allam et al. (1) is an important milestone in this journey into the history of ancient disease. Hopefully more such information with imaging will serve to complete the link between modern day disease and its distant predecessors.

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