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Computed Tomographic Assessment of Atherosclerosis in Ancient Egyptian Mummies

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bone resorption of vertebral bodies. Resorptions, which occurred within the first few weeks after spinal interbody fusion procedures assisted with BMP, have been clinically insignificant in some patients, but in others have resulted in serious complications (spacer subsidence, loss of correction, spacer dislodgement, and failure of spinal fusion).³

In the study by Tumialán et al,² no end plate resorption was reported. In contrast, a study by Vaidya et al,³ using the same interbody spacer and even smaller doses of BMP, reported 100% incidence of end plate resorption, resulting in subsidence of disc space in 40.5% of cervical levels. Improved surgical technique was emphasized by Tumialán et al⁴ as a reason for lack of resorption in their study, avoiding cortical end plate violations and therefore preventing contact between BMP and cancellous vertebral body, which can lead to osteolysis. However, a study by Slosar et al⁵ confirmed end plate violation during lumbar interbody fusions (interbody spacers were placed slightly deep and angulated) assisted with an even higher dose of BMP; no resorption and no subsidence was reported.

Besides dosing and containment of BMPs in spinal fusion procedures, there are other unidentified causes of important discrepancies in reported results, incidences of adverse effects, and clinical consequences. We agree with Cahill et al on the need for refined guidelines for BMP use and further study of the long-term risks and benefits of BMP.

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In Reply: We thank Dr Smoljanovic and colleagues for their comments regarding complications associated with BMP usage. As we noted in our article, the available data did not allow us to address the correlation between dos-

age of BMP and complication rate. We agree that additional work is needed to clarify the short-term and long-term complications associated with different dosages of BMP.

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RESEARCH LETTER

Computed Tomographic Assessment of Atherosclerosis in Ancient Egyptian Mummies

To the Editor: The current epidemic of atherosclerosis is commonly ascribed to risk factors associated with the modern human lifestyle. Computed x-ray tomographic (CT) imaging can visualize calcium hydroxyapatite in vessel walls and is widely regarded as pathognomonic of atherosclerosis.¹

Methods. To evaluate the presence of atherosclerosis in ancient humans, we performed whole-body, 6-slice CT using a Siemens Emotion 6 (Florsheim, Germany) on 22 mummies housed in the Egyptian National Museum of Antiquities in Cairo, Egypt, specifically searching for cardiac and vascular calcification. Mummies were selected for scanning based on a good state of preservation and were not randomly selected. Two mummies had been scanned previously and were included in this study because cardiovascular tissue was known to be present. The remaining 20 mummies underwent CT scanning in February 2009. Images were interpreted by consensus of 5 experienced cardiovascular imaging physicians (the authors).

Calcification in the wall of a clearly identifiable artery was considered diagnostic of atherosclerosis, and calcification along an artery's expected course was considered probable atherosclerosis. Age and sex were determined by biological anthropologic assessment and demographics assessed by a team of Egyptologists and preservationists. Identity or social position could be determined for 16 mummies; all were members of the pharaoh's court or priests or priestesses. Contrast-enhanced CT images obtained from a contemporary patient (who had provided written informed consent) were available for comparison.

Results. The imaged mummies lived between 1981 BCE and 334 CE. Computed tomographic images demonstrated identifiable aortic or peripheral vascular tissue in 15. The heart, but not the coronary arteries, could be identified in 4, 3 of whom also had identifiable aortic or peripheral vas-

cular tissue. Thus, 16 of 22 mummies (73%) had identifiable cardiovascular tissue (TABLE).

Definite atherosclerosis was present in 5 of 16 mummies (31%) and probable atherosclerosis in an additional 4 of 16 (25%). Among those who died when 45 years or older, calcification was present in 7 of 8 (87%) compared with 2 of 8 (25%) who died when younger than 45 years. Calcification was present in 4 of 7 women (57%) and 5 of 9 men (56%). The most ancient mummy with findings diagnostic of atherosclerosis was Lady Rai, nursemaid to Queen Amrose Nefertari, who died in approximately 1530 BCE at an estimated age of 30 to 40 years.

Representative CT examples of atherosclerosis in the thoracic aorta, abdominal aorta, and superficial femoral artery are shown in FIGURE A, B, and C, respectively. An analogous image of vascular calcification in a contemporary human with lumen enhancement by CT contrast is also shown.

Comment. Evidence of atherosclerosis has been reported based on pathologic examinations performed on several mummies in the early 1900s.^{2,3} Our findings that atherosclerosis was not infrequent among middle-aged and older ancient Egyptians of high social status challenges the view that it is a disease of modern humans. Regarding risk factors, although ancient Egyptians did not smoke tobacco or eat processed food or presumably lead sedentary lives, they were not hunter-gatherers. Agriculture was well established in ancient Egypt and meat consumption appears to have been common among those of high social status.⁴ The prevalence of diabetes and hypertension during this time is unknown.

Study limitations include lack of direct pathologic evidence of atherosclerosis in these mummies to correlate with CT findings. However, vascular calcification observed on CT scanning of contemporary humans is documented to be diagnostic of atherosclerosis.^{1,5} While the presence of calcification does not demonstrate that atherosclerosis was a com-

Table. Ancient Egyptian Mummy Demographics and Evidence of Vascular Calcification

Mummy No./Sex/Age at Death, y	Name	Social Position	Era	Era, y	Atherosclerosis	Calcified Artery
1/F/25-30	Unknown	Unknown	Greco-Roman	332 BCE–364 CE	No	No
2/F/25-30	Unknown	Unknown	Late	712-343 BCE	No	No
3/F/25-30	Tarepet	Daughter of Nestefet	Late	712-343 BCE	No	No
4/M/30-35	Unknown	Unknown	Ptolemaic	304-30 BCE	No	No
5/M/30-35	Tjanefer	Priest of Amun	Third intermediate	1070-712 BCE	Definite	Abdominal aorta
6/M/30-35	Esankh	Priest of Amun	Third intermediate	1070-712 BCE	No	No
7/M/30-35	Unknown	Unknown	Ptolemaic	304-30 BCE	No	No
8/F/30-40	Lady Rai	Nursemaid of queen	New Kingdom, early 18th dynasty	1570-1530 BCE	Definite	Aortic arch
9/F/45-50	Shtwsk	Unknown	Greco-Roman	332 BCE–364 CE	Probable	Bilateral popliteals and peroneals and left SFA
10/M/50-60	Wedjarenes	Unknown	Late	712-343 BCE	No	No
11/M/50-60	Nesmin	Son of Irheru	Ptolemaic	304-30 BCE	Probable	Bilateral SFA
12/M/50-60	Djeher	Unknown	Ptolemaic	304-30 BCE	Definite	Aortic arch, bilateral peroneals, right SFA
13/M/50-60	Anonymous	King's minister	New Kingdom, 18th dynasty	1550-1295 BCE	Definite	Bilateral anterior tibials, peroneals and popliteals
14/F/50-60	Anonymous	Wife of king's minister	New Kingdom, 18th dynasty	1550-1295 BCE	Definite	Abdominal aorta, left iliac, bilateral SFA
15/M/>50	Unknown	Unknown	Greco-Roman	332 BCE–364 CE	Probable	Right popliteal
16/F/>60	Unknown	Unknown	Ptolemaic	304-30 BCE	Probable	Right popliteal

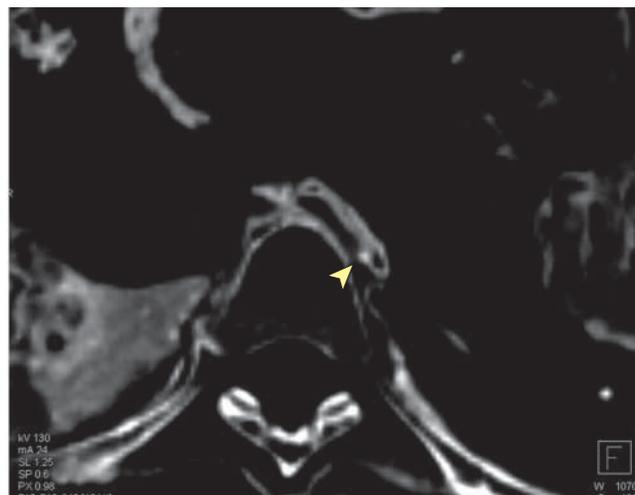
Abbreviation: SFA, superficial femoral artery.

Figure. Computed Tomographic Examples of Atherosclerosis in Ancient Egyptian Mummies and a Contemporary Human

A Calcification in thoracic aorta wall in mummy of Lady Rai



B Calcification in abdominal aortic wall in mummy of Tjanefer

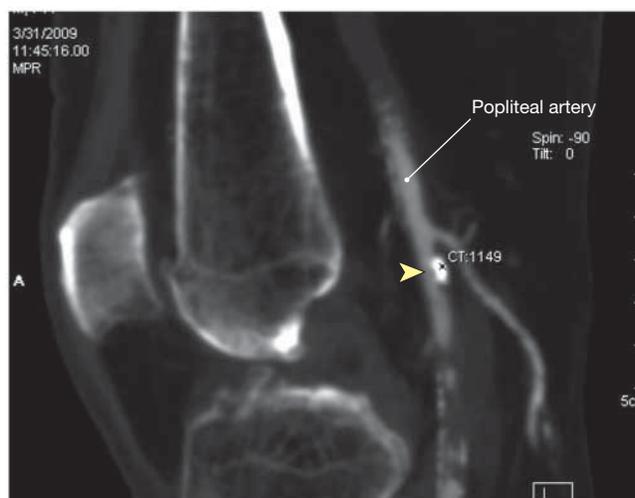


C Calcified plaque in mid lower extremity

Mummy No. 14



Living individual



A, Axial computed tomographic (CT) image demonstrating calcification in the wall of the thoracic aorta (arrowhead) at the level of the aortic arch in the mummy of Lady Rai, who lived during the early 18th Egyptian dynasty (mummy No. 8). B, Calcification in the wall of the abdominal aorta (arrowhead) in the mummy of Tjanefer, a man who lived during the third intermediate period (mummy No. 5). C, Longitudinal CT view of the leg demonstrating the superficial femoral artery with a calcified plaque (arrowhead) in the mummy of a woman who lived during the 18th dynasty (mummy No. 14). The density at this location measured 1530 Hounsfield units. The view of a CT angiogram of the living individual demonstrates a calcified plaque in a similar location with a comparable density measurement to mummy No. 14.

mon cause of clinically manifest disease or death, it does provide evidence that humans in ancient times had the genetic predisposition and environment to promote the development of atherosclerosis.

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Author Contributions: Dr Thomas had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Allam, Thompson, Wann, Miyamoto, Thomas.

Acquisition of data: Allam, Thompson, Wann, Miyamoto, Thomas.

Analysis and interpretation of data: Allam, Thompson, Wann, Miyamoto, Thomas.

Drafting of the manuscript: Allam, Thompson, Wann, Miyamoto, Thomas.

Critical revision of the manuscript for important intellectual content: Allam, Thompson, Wann, Miyamoto, Thomas.

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Study supervision: Allam, Thompson, Wann, Miyamoto, Thomas.

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Of course you will insist on modesty in the children,
and respect to their teachers, but if the boy stops you
in your speech, cries out that you are wrong and sets
you right, hug him!

—Ralph Waldo Emerson (1803-1882)