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). In the study by Tumialan et al, no end plate resorption was reported. In contrast, a study by Vaidya et al, using the same interbody spacer and even smaller doses of BMP, reported 100% incidence of end plate resorption, concluding in subsidence of disc space in 40.5% of cervical levels. Improved surgical technique was emphasized by Tumialan et al 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 al 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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Financial Disclosures: None reported.


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-
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

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

Abbreviation: SFA, superficial femoral artery.
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.

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

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.
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. Obtained funding: Allam, Thompson, Wann, Thomas. Administrative, technical, or material support: Allam, Thompson, Wann, Miyamoto, Thomas. Study supervision: Allam, Thompson, Wann, Miyamoto, Thomas.

Financial Disclosures: Dr Thompson reported receiving lecture honoraria from Pfizer, Merck, and AstraZeneca. Dr Thomas reported receiving lecture honoraria from Abbott and Merck, consulting fees from General Electric, and research support from ISIS and Hoffman-La Roche. No other disclosures were reported.

Funding/Support: This investigator-initiated study was supported by the National Bank of Egypt, Cairo; Siemens Healthcare, Florsheim, Germany; and St Luke’s Hospital Foundation, Kansas City, Missouri.

Role of the Sponsors: The funding sources had no role in the design and conduct of the study; in the collection, analysis, and interpretation of the data; or in the preparation, review, or approval of the manuscript.

Previous Presentation: Presented in part at the Annual Scientific Sessions of the Society of Cardiovascular Computed Tomography; July 19, 2009; Orlando, Florida; and to be presented at the Annual Scientific Sessions of the American Heart Association, November 17, 2009; Orlando, Florida.

Additional Contributions: The Egyptology and preservationist group was an integral part of the research team, guiding selection and determination of the demographics and historical relevance of the mummies, and it received financial support. They were led by Abd el-Halim Nur el-Din, PhD (Cairo University, Giza, Egypt), with Gomaa Abd el-Maksoud, PhD (Cairo University), and Ibrahim Badr, PhD (Institute of Restoration, Alexandria, Egypt). Nasry Iskander, PhD (Center of Research, Supreme Council of Antiquities, Cairo, Egypt), also added significant contributions and received financial support: Hany Abd el-Amer, PhD (National Research Center, Dokki, Giza), was instrumental in the CT scanning and received financial support. The authors are grateful to Zahi Hawass, PhD (Secretary General of the Supreme Council of Antiquities, Egyptian Ministry of Culture), for allowing us to scan these mummies; to Muhammad Al-Tohamy Soliman, PhD (National Research Centre, Cairo), for performing the anthropological measurements to estimate the age and sex of the mummies; and to Jennifer I. Thomas, PhD (Massachusetts General Hospital, Boston), for her data analysis and critical review of the letter; these individuals did not receive financial compensation for their contributions.

1. Budoff MJ, Achenbach S, Blumenthal RS, et al; American Heart Association Committee on Cardiovascular Imaging and Intervention; American Heart Association Council on Cardiovascular Radiology and Intervention; American Heart Association Committee on Cardiac Imaging, Council on Clinical Cardiology. Assessment of coronary artery disease by cardiac computed tomography: a scientific statement from the American Heart Association Committee on Cardiovascular Imaging and Intervention, Council on Cardiovascular Radiology and Intervention, and Committee on Cardiac Imaging, Council on Clinical Cardiology. Circulation. 2006;114(16):1761-1791.


