



Atherosclerosis in 16th-Century Greenlandic Inuit Mummies

L. Samuel Wann, MD; Jagat Narula, MD, PhD; Ron Blankstein, MD; Randall C. Thompson, MD; Bruno Frohlich, PhD; Caleb E. Finch, PhD; Gregory S. Thomas, MD, MPH

Introduction

Atherosclerosis is often thought of as unique to modern *Homo sapiens*, the product of our contemporary diet, lifestyle, and environment superimposed on primordial susceptibility. However, the HORUS Study Group has found that atherosclerosis existed at least as far back as 4000 BCE.¹ Arterial calcification has been found in 34 of 137 mummified remains from 3 continents across wide variations in lifestyle and heritage, including in hunter-gatherer populations.^{1,2} None of these individuals consumed a primarily marine-based diet rich in ω -3 fatty acids. Fifty years ago, Danish researchers³ hypothesized that high intake of marine animals rich in fish oil containing ω -3 fatty acids protected native Greenlandic Inuit peoples from atherosclerosis. Davis and colleagues⁴ found fish oil reduced the atherosclerosis induced in rhesus monkeys exposed to a high-cholesterol atherogenic diet. In 2019,⁵ interest persists in the actions of ω -3 fatty acids in their natural and highly purified forms. To better understand the early history of human atherosclerosis, we performed a case series study of Inuit hunter-gatherer people living 500 years ago who consumed a marine-based diet.

Author affiliations and article information are listed at the end of this article.

Methods

Five Inuit mummies curated at the Peabody Museum of Archaeology and Ethnology, Cambridge, Massachusetts, were studied at the Heart and Vascular Center of the Brigham and Women's Hospital, Boston, Massachusetts. Permission to perform imaging was granted by the Peabody Museum of Archaeology and Ethnology. These natural mummies, preserved primarily by the cold environment, were discovered by Martin Luther on the Greenlandic island of Uunartaq, Greenland, in 1929.⁶ Grave goods and typical clothing indicated burial in the 1500s, when these individuals would have lived in stone, whale bone, and seal skin huts and hunted from kayaks with spears, bows, and arrows for their diet of fish, birds, marine mammals, and caribou.

Multidetector whole-body computed tomography (CT) images were obtained at 80 and 120 kV with 6-mm slice thickness with 50% overlap and reconstructed using multiple kernels with a third-generation dual-source CT scanner (Siemens). Images were reviewed and interpreted by consensus of 5 cardiologists (L.S.W., J.N., R.B., R.C.T., and G.S.T.) and 2 radiologists with extensive experience interpreting mummy CT images. Age and sex were estimated from bone and dental development by a physical anthropologist (B.F.).

Results

An infant mummy was excluded from further analysis owing to paucity of non-bony tissue. Based on skeletal and dental features, the remaining mummies were adolescents or young adults, including 2 men who died at ages 18 to 22 years and 25 to 30 years and 2 women who died at ages 16 to 18 years and 25 to 30 years (**Figure 1**). The causes of death could not be determined. Remnants of the carotid arteries, the thoracic and retroperitoneal aorta, and iliac arteries were preserved in all 4 individuals, but reliable anatomic landmarks within the heart could not be identified. Three mummies had evidence of calcified atheroma, identified as discrete high-density regions in an arterial distribution (**Figure 2**). Incomplete visualization of the arterial vascular tree precluded accurate grading of the magnitude or severity of vascular calcification and evaluation of clinical disease. Nevertheless, the appearance of vascular calcification in these 3 mummies resembled previous observations of atherosclerosis in mummies and living humans.

Open Access. This is an open access article distributed under the terms of the CC-BY License.

Discussion

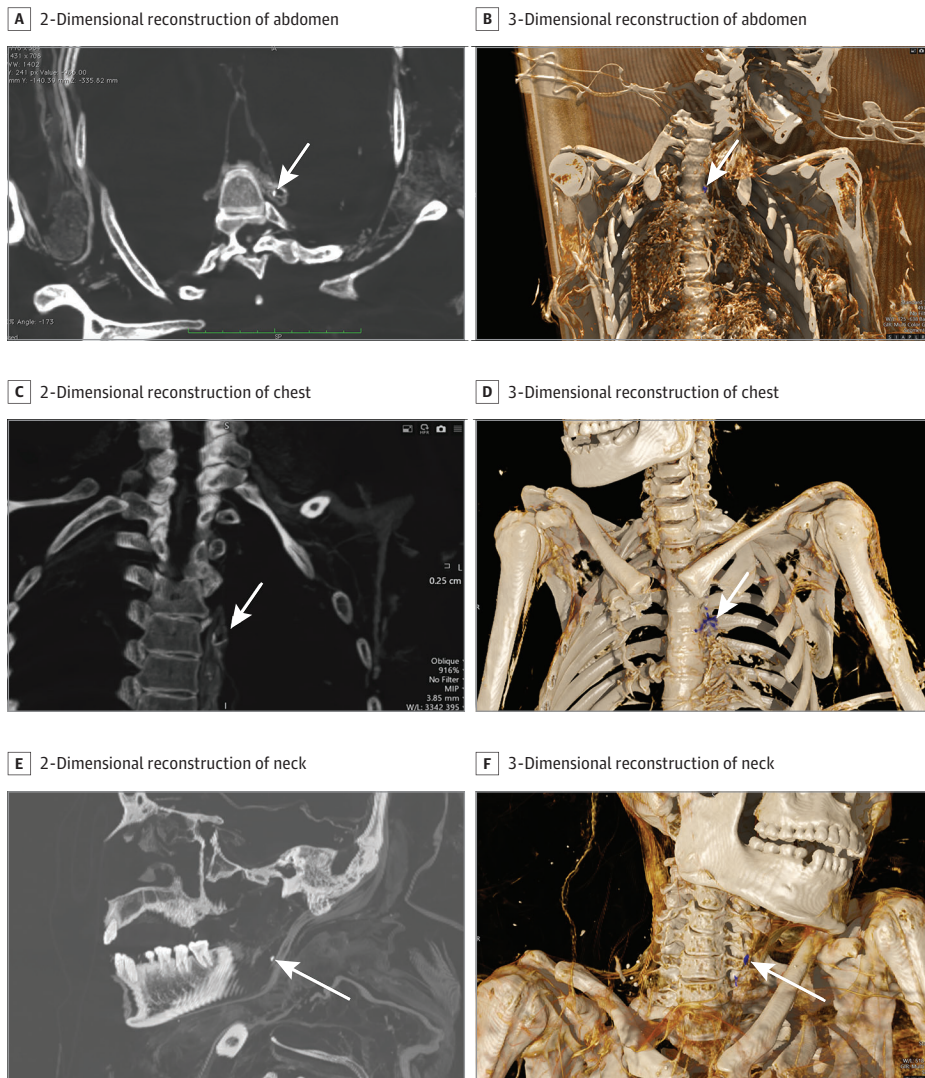
This cases series presents evidence for the presence of calcified plaques in the mummified remains of 3 young Inuit individuals living 500 years ago, suggesting the presence of atherosclerosis despite their vigorous lifestyle and marine-based diet. While we cannot know the incidence of ancient ischemic events, cardiovascular deaths were rare among mid-20th century Inuit people, similar to contemporary Amazonian Tsimane people, who have low-grade atherosclerosis and low incidence of

Figure 1. Adult Inuit Mummified Individual Who Was Scanned With Computed Tomography



Courtesy of the Peabody Museum of Archeology and Ethnology, Harvard University, PM 29-10-10/61570.0.

Figure 2. Computed Tomography Images Showing Calcified Atherosclerotic Plaques



Arrows indicate calcified atherosclerotic plaques.

cardiovascular death.⁷⁻⁹ The etiologic complexity of atherosclerosis confounds identification of single factors, such as ω -3 fatty acids, as causal or protective. Other factors may include environmental smoke,¹⁰ which is produced by indoor fires used by Inuit and many other ancient peoples who also incurred atherosclerosis.

ARTICLE INFORMATION

Accepted for Publication: October 2, 2019.

Published: December 27, 2019. doi:[10.1001/jamanetworkopen.2019.18270](https://doi.org/10.1001/jamanetworkopen.2019.18270)

Open Access: This is an open access article distributed under the terms of the [CC-BY License](https://creativecommons.org/licenses/by/4.0/). © 2019 Wann LS et al. *JAMA Network Open*.

Corresponding Author: L. Samuel Wann, MD, Ascension Healthcare, 4175 N Oakland Ave, Milwaukee, WI 53211 (samuelwann@gmail.com).

Author Affiliations: Ascension Healthcare, Milwaukee, Wisconsin (Wann); Icahn School of Medicine at Mount Sinai, New York, New York (Narula); Brigham and Women's Hospital, Boston, Massachusetts (Blankstein); St Luke's Mid-America Heart Institute, Kansas City, Missouri (Thompson); Smithsonian Institution, Washington, DC (Frohlich); University of Southern California, Los Angeles (Finch); Memorial Care Heart & Vascular Institute, Fountain Valley, California (Thomas).

Author Contributions: Dr Wann 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.

Concept and design: Wann, Thompson, Finch, Thomas.

Acquisition, analysis, or interpretation of data: Wann, Narula, Blankstein, Thompson, Frohlich, Thomas.

Drafting of the manuscript: Wann, Thompson, Frohlich, Thomas.

Critical revision of the manuscript for important intellectual content: Wann, Narula, Blankstein, Thompson, Finch, Thomas.

Statistical analysis: Wann, Frohlich.

Obtained funding: Frohlich.

Administrative, technical, or material support: Wann, Blankstein, Thompson, Frohlich, Thomas.

Supervision: Wann.

Conflict of Interest Disclosures: None reported.

Funding/Support: The Paleocardiology Foundation, a nonprofit charity unrelated to industry, provided funds to transport the mummies from the Peabody Museum to Brigham and Women's Hospital, where computed tomography scanning was performed without charge.

Role of the Funder/Sponsor: The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Additional Contributions: All authors are members of the Horus Study Group. Other Horus Study Group members who participated in the study design and data analysis included Adel H. Allam, MD (Al-Azar University); Guido P. Lombardi, MD, MS (Universidad Peruana Cayetano Heredia); Crystal Medina, MD, MPH, and David E. Michalik, DO (University of California, Irvine); Michael I. Miyamoto, MD (Providence St. Joseph Health); Christopher J. Rowan, MD (Renown Hospital Nevada); M. Linda Sutherland, MD, and James D. Sutherland, MD, MS (Memorial Care Heart & Vascular Institute); Michael L. Steigner MD (Brigham and Women's Hospital); Emily M. Venable, AB (Harvard University); and Albert R. Zink, PhD (Eurac Research). They were not compensated for their contributions.

REFERENCES

1. Thompson RC, Allam AH, Lombardi GP, et al. Atherosclerosis across 4000 years of human history: the Horus study of four ancient populations. *Lancet*. 2013;381(9873):1211-1222. doi:[10.1016/S0140-6736\(13\)60598-X](https://doi.org/10.1016/S0140-6736(13)60598-X)
2. Zimmerman MR, Yeatman GW, Sprinz H, Titterton WP. Examination of an Aleutian mummy. *Bull N Y Acad Med*. 1971;47(1):80-103.
3. Bang HO, Dyerberg J, Nielsen AB. Plasma lipid and lipoprotein pattern in Greenlandic West-coast Eskimos. *Lancet*. 1971;1(7710):1143-1145. doi:[10.1016/S0140-6736\(71\)91658-8](https://doi.org/10.1016/S0140-6736(71)91658-8)
4. Davis HR, Bridenstine RT, Vesselinovitch D, Wissler RW. Fish oil inhibits development of atherosclerosis in rhesus monkeys. *Arteriosclerosis*. 1987;7(5):441-449. doi:[10.1161/01.ATV.7.5.441](https://doi.org/10.1161/01.ATV.7.5.441)

5. Bhatt DL, Steg PG, Miller M, et al; REDUCE-IT Investigators. Cardiovascular risk reduction with icosapent ethyl for hypertriglyceridemia. *N Engl J Med*. 2019;380(1):11-22. doi:[10.1056/NEJMoa1812792](https://doi.org/10.1056/NEJMoa1812792)
6. Hooten EA. Lapps, Eskimos, and Martin Luther. *Harvard Alumni Bulletin*. 1930;32(19):545-553.
7. Allam AH, Mandour Ali MA, Wann LS, et al. Atherosclerosis in ancient and modern Egyptians: the Horus study. *Glob Heart*. 2014;9(2):197-202. doi:[10.1016/j.gheart.2014.03.2454](https://doi.org/10.1016/j.gheart.2014.03.2454)
8. Kaplan H, Thompson RC, Trumble BC, et al. Coronary atherosclerosis in indigenous South American Tsimane: a cross-sectional cohort study. *Lancet*. 2017;389(10080):1730-1739. doi:[10.1016/S0140-6736\(17\)30752-3](https://doi.org/10.1016/S0140-6736(17)30752-3)
9. Wann LS, Lombardi G, Ojeda B, et al. The Tres Ventanas Mummies of Peru. *Anat Rec (Hoboken)*. 2015;298(6):1026-1035. doi:[10.1002/ar.23137](https://doi.org/10.1002/ar.23137)
10. Rajagopalan S, Al-Kindi SG, Brook RD. Air pollution and cardiovascular disease: JACC State-of-the-Art review. *J Am Coll Cardiol*. 2018;72(17):2054-2070. doi:[10.1016/j.jacc.2018.07.099](https://doi.org/10.1016/j.jacc.2018.07.099)