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Ancient Egypt: a cradle of cardiovascular surgery

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Abstract

Background The origins of cardiovascular knowledge are deeply rooted in ancient Egyptian civilization, where the heart occupied an unparalleled position in medicine, theology, and cultural identity.

Main Drawing primarily from the Ebers Papyrus (ca. 1550 BCE) and the Edwin Smith Papyrus (ca. 1600 BCE), this review examines how ancient Egyptian physicians developed remarkably sophisticated concepts of cardiovascular anatomy, pathology, and even rudimentary surgical intervention, a millennium before the Hippocratic tradition. The Ebers Papyrus contains what is plausibly the first treatise on cardiology in human history, describing the heart as the center of a distributive vascular system composed of 22 vessels (mtw), recognizing the relationship between the peripheral pulse and cardiac function, and cataloguing a range of cardiac pathologies including what may represent early descriptions of heart failure and angina. The Edwin Smith Papyrus, distinguished by its rational and empirical approach, provides the earliest known surgical case reports, including descriptions of thoracic injuries and their cardiovascular consequences. Notably, the Ebers Papyrus also documents what is among the oldest surviving descriptions of an arterial aneurysm and its surgical treatment by cautery. Furthermore, modern paleopathological investigations using computed tomography have revealed widespread atherosclerotic disease in Egyptian mummies, confirming that cardiovascular pathology is not exclusively a disease of modernity.

Conclusion Ancient Egypt represents an important cradle of circulation knowledge and a main intellectual birthplace of cardiovascular surgery.

Keywords Ancient Egypt, Ebers Papyrus, Edwin Smith Papyrus, Cardiovascular surgery, History of medicine

Introduction

The history of cardiovascular surgery is conventionally narrated as a twentieth-century achievement, beginning with Ludwig Rehn's repair of a stab wound to the right ventricle in 1896 and culminating in the spectacular era of open-heart surgery enabled by cardiopulmonary bypass [1]. However, the conceptual foundations upon which modern heart surgery rests, an understanding of the heart as a central organ, a recognition of its relationship to a system of vessels, and the courage to intervene surgically upon vascular pathology, were laid not in nineteenth-century Europe but in the Nile Valley more than three millennia earlier. Ancient Egypt, a civilization that

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flourished from approximately 3100 BCE to 332 BCE, produced the earliest known systematic medical literature, the most detailed pre-modern understanding of the cardiovascular system, and the first documented surgical treatment of a vascular lesion [2–4].

The purpose of this review is to examine the ancient Egyptian contributions to cardiovascular knowledge that constitute the intellectual and practical antecedents of modern heart surgery. Drawing on the primary medical papyri and contemporary Egyptological scholarship, it will trace how Egyptian physicians conceived of the heart and its vessels, catalogued cardiac pathologies, performed rudimentary vascular surgery, and left behind a biological record in their mummified remains that continues to yield insights into cardiovascular disease today.

For the purposes of this review we define our terms as follows. By *circulation knowledge* we mean an articulated understanding of the heart as the origin of a system of vessels that distributes blood (and, in the Egyptian conception, also air and other fluids) to the body; we do not use the term in the modern Harveian sense of a closed, unidirectional circuit driven by the heart as a mechanical pump, a concept not established until Harvey (1628) and, for the pulmonary circuit, first described by Ibn al-Nafis in the thirteenth century. By *cardiovascular surgery* in the ancient context we mean deliberate operative intervention upon the heart or a blood vessel to treat disease or injury (here exemplified by the treatment of a vascular swelling in Ebers § 872). Our central claim is one of documented priority: that ancient Egypt provides the earliest surviving written record uniting a heart-centred vascular model, pulse-based diagnosis, and operative treatment of a vascular lesion. This claim is distinct from, and asserts no superiority over, the later and technically more advanced vascular procedures of Greco-Roman surgery (e.g., Antyllus).

The medical papyri: primary sources of cardiovascular knowledge

Knowledge of ancient Egyptian medical practices derives principally from approximately a dozen surviving papyri written in hieratic script, dating from ca. 1550 BCE to 300 BCE [2, 5]. Of these, two are of paramount importance for cardiovascular history: the Ebers Papyrus and the Edwin Smith Papyrus. Beside this, an alabaster bowl bearing the name of Athotis, a king who lived around 3050 BC during the first dynasty (approximately 1500 years before the Eber papyrus), has been interpreted as depicting the heart and six vessels arising from the organ [6]. Therefore, this finding may suggest that anatomy of the cardiovascular system preceded the appearance of the Eber papyrus.

The Ebers Papyrus

The Ebers Papyrus (ca. 1550 BCE), a 20-meter-long scroll containing over 800 prescriptions and remedies, provides the most extensive account of Egyptian cardiovascular knowledge [3, 7]. Its "Vessel Book" (Sections. 854–856) constitutes what many scholars consider the first treatise on cardiology in human history [8, 9]. The papyrus declares that "knowing the movements of the heart" is "the beginning of the secrets of the physician," establishing the heart as the diagnostic cornerstone of Egyptian medicine [3, 5]. The Ebers Papyrus describes 22 vessels (mtw) emanating from the heart and distributing to all parts of the body, including the limbs, eyes, and viscera [3, 5]. Although the concept of mtw encompassed not only blood vessels but also conduits for air, urine, tears, and other bodily fluids, the fundamental insight that the heart served as the origin of a unidirectional distributive system was remarkably prescient [2, 5]. Egyptian physicians further recognized a connection between the heart and lungs, teaching that air entering the nose was conveyed to the heart and lungs, which then distributed it throughout the body, a proto-physiological concept that, although inexact, anticipated the later recognition of pulmonary circulation by millennia [3, 10]. Perhaps most significantly for the history of heart surgery, the Ebers Papyrus contains the oldest known description of cardiac pathology [11, 12]. The text describes conditions such as the "heart is flooded," which has been interpreted as an early description of congestive heart failure, and the "heart is deflected," referring to an enlarged heart displaced toward the stomach [8, 11]. Other passages describe debility of the heart, a weakened or silent pulse ("the heart does not speak" or "the vessels of the heart are dumb"), and a range of conditions that suggest the Egyptians were attempting to classify cardiac diseases based on clinical observation [8, 11].

The Edwin Smith Papyrus

The Edwin Smith Papyrus (ca. 1600 BCE), widely considered the oldest known surgical treatise, adopts a strikingly rational and empirical approach to medicine that stands in marked contrast to the magico-religious elements found in other papyri [12, 13] (Fig. 1). Its 48 surgical cases proceed in an orderly fashion from head to trunk, and several cases describe thoracic injuries with explicit cardiovascular implications. Case 34, for instance, describes a sternoclavicular dislocation and identifies two vessels in the upper chest carrying blood to the respiratory tract, an observation that demonstrates an awareness of the thoracic vasculature and its clinical significance [5, 12].

The Edwin Smith Papyrus is notable for its systematic approach to examination, diagnosis, and prognosis, classifying each case as "an ailment which I will treat," "an

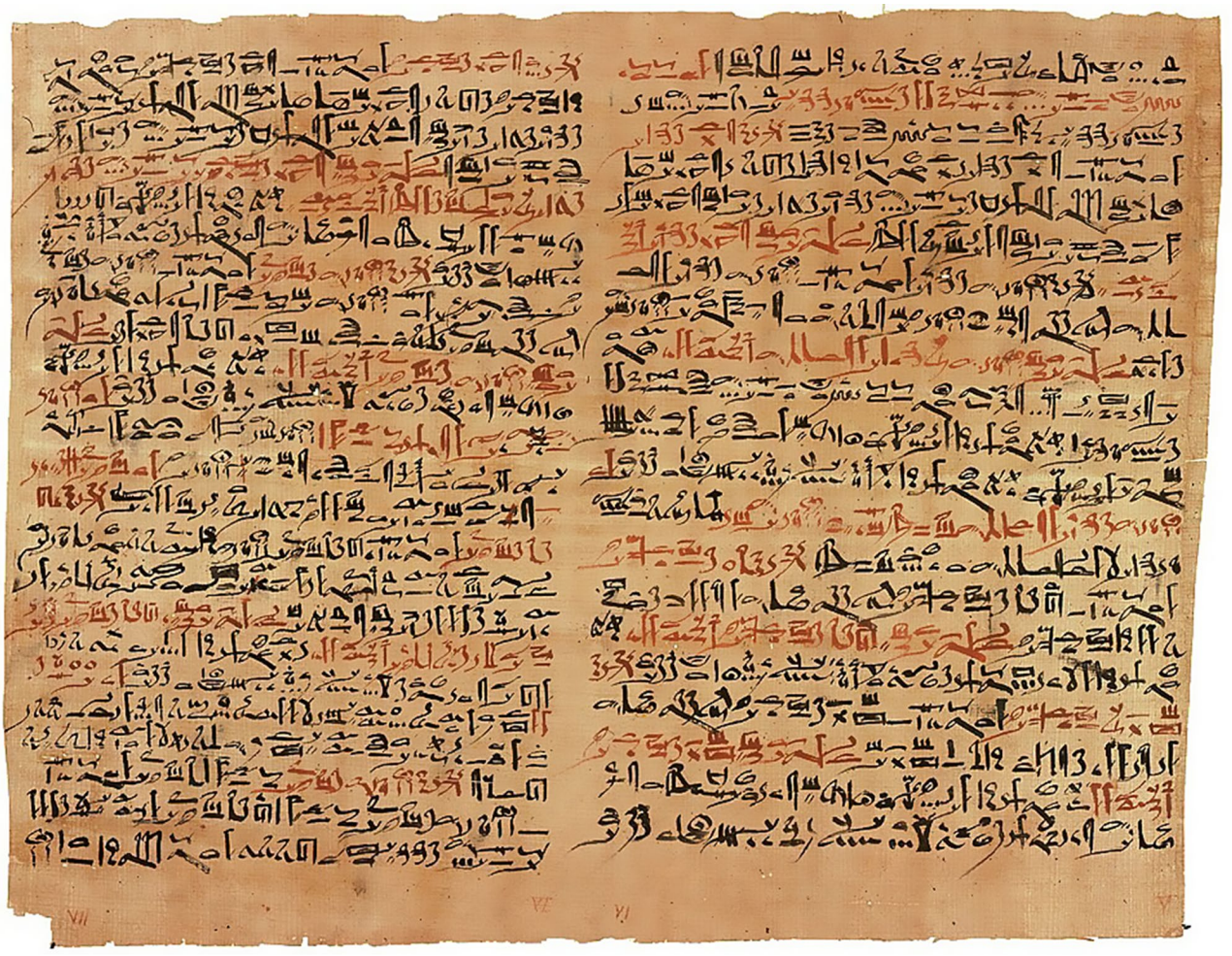


Fig. 1 Plates VI and VII of the Edwin Smith Papyrus (ca. 1600 BCE), the oldest known surgical treatise. Written in hieratic script, the text presents 48 surgical cases in a systematic format of examination, diagnosis, and treatment. Cases in these columns discuss facial trauma (Cases 12–20). The papyrus is housed at the New York Academy of Medicine. Public domain. Source: Wikimedia Commons. Available at: https://commons.wikimedia.org/wiki/File:Edwin_Smith_Papyrus_v2.jpg (Public Domain / CC0). Original image courtesy of the U.S. National Library of Medicine, National Institutes of Health

ailment with which I will contend," or "an ailment not to be treated," a triage system that has drawn comparisons to modern clinical decision-making [12, 13]. For thoracic injuries, the papyrus describes the assessment of wound depth, evaluation of the pulse, and observation of respiratory compromise, all elements that form the foundation of thoracic surgical evaluation.

The pulse: the first cardiovascular diagnostic tool

One of the most remarkable contributions of Egyptian medicine to the history of cardiovascular surgery is the recognition that the peripheral pulse originates from the heart and that its assessment provides diagnostic information about the patient's condition [3, 10, 14]. The Edwin Smith Papyrus instructs the physician to place fingers on the head, hands, or limbs to "measure the heart," recognizing that the beating felt at these sites reflects the activity of the central organ [10]. Although some scholars debate whether the Egyptians formally measured the pulse (as they lacked a timekeeping device), the conceptual breakthrough of linking the peripheral pulse to cardiac function predated comparable Greek knowledge by over a millennium [5, 15].

This insight was not merely theoretical. Egyptian physicians used pulse assessment in clinical practice, noting when the vessels were "dumb" (impalpable) or abnormally strong, and correlating these findings with disease states [8, 11]. In the context of cardiovascular surgical history, this represents the first documented instance of using the cardiovascular system as a diagnostic tool, a practice that remains the cornerstone of every heart operation today.

Pioneer cardiovascular surgical intervention

Perhaps the most directly relevant passage for the history of cardiovascular surgery is found in Section 872 of the Ebers Papyrus, which contains what is widely considered

the oldest known description of an arterial aneurysm and its surgical treatment [5, 16, 17]:

> *When thou considereth a swelling of the vessels on any part of the man's body and thou findst it globular [and] firm under thine fingers when going [pulsating?]…then thou shalt say: 'this is a vessel swelling, a disorder I will treat. It is the vessels that cause it. It originates from an injury upon the vessel.' Then thou shalt apply to it treatment with the knife; this [the knife] is heated in fire; the bleeding will not be considerable [16]*

First, the passage demonstrates accurate clinical examination: the description of a pulsatile, globular, firm swelling is consistent with the physical characteristics of an aneurysm. Second, the proposed etiology (an injury upon the vessel) suggests a pseudoaneurysm, demonstrating pathophysiological reasoning. Third, in our interpretation the cautery would have obliterated flow within the affected vessel; we emphasize, however, that the passage as preserved does not itself state that arresting flow abolished the pulsation [5]. Finally, the recommended treatment by cauterization, while no longer practiced, represented a simple and reasonably effective intervention for its era [5].

As Barr noted, this passage documents the pioneer vascular surgical [5]. Although the distinction between "vascular surgery" and "cardiac surgery" was meaningless in antiquity (and indeed remained so until the late nineteenth century), the willingness and ability to intervene surgically on a diseased vessel represents a conceptual milestone that directly anticipates the later development of cardiovascular surgery as a discipline.

The practitioners: specialization in ancient Egyptian medicine

The organization of medical practice in ancient Egypt further supports the claim of a nascent cardiovascular surgical tradition. Egyptian society supported at least three types of medical practitioners: priests who prayed for divine healing, magicians who offered spells and incantations, and the swnw (doctor), naturalistic healers who relied on medications and surgical procedures to treat disease [2, 5, 7]. Remarkably, the swnw demonstrated organ-system specialization, a level of professional differentiation not seen again until the modern era [2]. Herodotus, visiting Egypt in ca. 450 BCE, observed that each physician treated only one disease, and that the country was full of such specialists [18]. The conditions that permitted this degree of specialization, the agricultural surplus provided by the Nile, geographic isolation affording generations of peace, a highly organized bureaucracy, and the early development of writing to preserve and transmit knowledge, were uniquely present in the Egyptian context [2, 5]. Together, these factors created an environment in which cardiovascular knowledge could be systematically developed, recorded, and refined over centuries.

The heart in Egyptian religion and culture

The prominence of the heart in Egyptian medicine cannot be separated from its extraordinary cultural and theological significance [19, 20]. In ancient Egyptian belief, the heart was the seat of the intellect, emotion, and moral essence of the individual. Unlike the brain, which was discarded during mummification, the heart was carefully preserved within the body, reflecting its perceived indispensability for the afterlife [19, 21]. In the celebrated "Weighing of the Heart" ceremony depicted in the Book of the Dead, the heart of the deceased was weighed against the feather of Ma'at (truth and justice) to determine the soul's worthiness for eternal life (Fig. 2) [19, 20]. If the heart was heavier than the feather, the soul was devoured by Ammit; if it balanced or was lighter, the deceased was granted passage into the afterlife. This cultural investment in the heart had profound implications for the development of medical knowledge. The theological imperative to protect and understand the heart likely drove the systematic inquiry that produced the Vessel Book of the Ebers Papyrus and the cardiovascular observations in the Edwin Smith Papyrus [8, 19]. It is a compelling irony of history that the same reverence for the heart that motivated its study may also have inhibited surgical intervention upon it, a tension between the sacred and the surgical that would persist until the modern era [22].

Paleopathology: cardiovascular disease in antiquity

The practice of mummification in ancient Egypt has provided a unique window into the cardiovascular health of an ancient population. Paleopathological investigations of Egyptian mummies have identified atherosclerotic disease for well over a century [23, 24]. As early as 1852, histologic examination of mummies revealed aortic calcifications, and in 1909, Shattock described atherosclerotic changes in the aorta of Pharaoh Merneptah, who reigned between ca. 1213 and 1203 BCE [25–27].

The most comprehensive modern investigation is the Horus Study, which used whole-body computed tomography to examine 52 mummies spanning the Middle Kingdom to the Greco-Roman period [28, 29]. Of 44 mummies with identifiable cardiovascular structures, 20 (45%) had probable or definite atherosclerosis, with calcifications found in the aorta, coronary, carotid, iliac, femoral, and peripheral leg arteries [29]. A subsequent multicultural extension of the Horus Study, examining mummies from four ancient populations across three continents, found that atherosclerosis was common



Fig. 2 The "Weighing of the Heart" scene from the Book of the Dead of Hunefer (ca. 1275 BCE, 19th Dynasty). Left to right: Anubis, the jackal-headed god, leads the deceased Hunefer into the Hall of Judgment and supervises the weighing of his heart (represented as a pot) against the feather of Ma'at on a balance scale. The ibis-headed god Thoth records the verdict. The monster Ammit (part crocodile, part lion, part hippopotamus) awaits to devour the heart if it proves heavier than the feather. Finally, the falcon-headed Horus presents the justified Hunefer to Osiris, enthroned with Isis and Nephthys. The ancient Egyptians considered the heart the seat of intellect, emotion, and moral character, the only organ preserved intact during mummification. Painted papyrus, 45.7 × 83.4 cm. The British Museum, London (EA9901.3). Source: Wikimedia Commons. Available at: https://commons.wikimedia.org/wiki/File:The_judgement_of_the_dead_in_the_presence_of_Osiris.jpg (Public Domain). Original photograph by the British Museum. Also available via: The British Museum Collection Online, https://www.britishmuseum.org/collection/object/Y_EA9901-3

across geographically and temporally diverse civilizations, challenging the prevailing assumption that it is exclusively a disease of modern lifestyles [30].

These paleopathological findings carry important implications. They demonstrate that the cardiovascular diseases that modern cardiovascular surgery aims to treat (coronary artery disease, peripheral vascular disease, and aortic atherosclerosis) have afflicted humanity for millennia [31–34].

These findings shall be read with caution [35]. First, computed tomography detects vascular calcification but cannot reliably distinguish atherosclerotic intimal calcification from medial (Mönckeberg-type) calcification, so a calcified vessel is not by itself evidence of occlusive atherosclerotic disease. Second, the mummified individuals available for study (frequently of elite status and preferentially preserved) are unlikely to be representative of the general ancient population. Third, embalming, desiccation, and post-mortem change may distort tissue planes and complicate the identification and localization of vascular structures. Fourth, calcification alone does not permit reliable inference of clinical ischemic events during life.

Discussion

The evidence reviewed here supports the thesis that ancient Egypt represents the intellectual birthplace of cardiovascular surgery. The term "birthplace" requires careful qualification: no Egyptian physician performed open-heart surgery. What the Egyptians did achieve, however, was no less foundational. They established the heart as the central organ of a vascular system; they developed the systematic methods of cardiovascular diagnosis through pulse assessment; they catalogued cardiac pathologies with a sophistication unmatched until the Hippocratic era; and they documented a surgical intervention for a vascular lesion [2, 3, 5].

It is important to acknowledge what the Egyptians did not accomplish. As Barr has observed, the absence of postmortem dissection precluded detailed anatomical localization, and contrary to popular belief, physicians' anatomical knowledge did not benefit substantially from the embalming process [5]. Nevertheless, the ancient Egyptian process of extracting the brain tissues using a bronze crochet inserted through the nose during mummification, for instance, reflects a good application of anatomical knowledge. The extraction of certain viscera to be preserved separately in the so-called "canopic jars," also required anatomical knowledge. The heart's connection to a network of blood vessels was probably discovered through mummification. The lung was among the

Table 1 Mapping of key papyrus passages to modern clinical interpretations, with transliteration and confidence ratings

Papyrus / section	Original term transliteration	Translation	Clinical interpretation	Confidence
Ebers § 854–856 (Vessel Book)	mt.w (sing. mt)	"vessels / conduits"	Heart as origin of a distributive vascular system	Moderate: mt.w also denotes non-vascular conduits (air, urine, tears)
Ebers, Vessel Book	ḥ3tj / jb (haty / ib)	"heart"	Heart as the central organ of the body	High
Ebers, Vessel Book	rḫ šm.t ḥ3tj (rekh shemet haty), "knowledge of the course of the heart"; the physician ḫ3j (khai), "measures," it	"knowing the movements of the heart"	Peripheral pulse linked to cardiac activity	High
Ebers	ḥ3tj / jb (haty / ib); flooding verb of the gloss per Bardinet [37]	"the heart is flooded"	Possible congestive heart failure	Speculative
Ebers	ḥ3tj / jb (haty / ib); displacement verb of the gloss per Bardinet [37]	"the heart is deflected"	Enlarged / displaced heart	Speculative
Ebers § 854	mdwj (medu), "to speak": the ḥ3tj "speaks" through the mtw; the gloss negates this	"the heart does not speak" / "the vessels are dumb"	Impalpable or weak pulse	Moderate
Ebers § 872	ʿ3.t (aat), "swelling/tumour," of the mtw	"swelling of the vessels" / "vessel swelling"	Arterial aneurysm (possibly pseudoaneurysm), treated by cautery	Moderate: differential includes other vascular/soft-tissue swellings
Edwin Smith, Case 34	mt / mtw (met), "vessel(s)"	"two vessels … to the respiratory tract"	Awareness of thoracic vasculature	Moderate

Transliteration follows Egyptological convention (aleph written as 3), with a plain reading in parentheses. Terms are taken from the Thesaurus Linguae Aegyptiae [38], cross-checked against Bardinet [37] and Wreszinski [39]. Confidence: High = broadly attested in the primary Egyptological editions; Moderate = plausible but interpretation-dependent; Speculative = tentative extrpolation

organs that were preserved in canopic jars. So, extracting it required knowledge of its anatomical relations, including the great vessels. Dissection for scientific purposes was not known in that era, and mummification was one of the sources of ancient Egyptian anatomical knowledge [29, 30]. The cardiovascular system is the best-elucidated organ system in ancient Egyptian medicine, a testament to the central importance of the heart in their civilization [5, 8].

Situating the Egyptian material against other early vascular traditions strengthens this thesis. In the Greco-Roman world, the most developed early account of aneurysm surgery is attributed to Antyllus (fl. second century CE), who described proximal and distal ligation of the vessel followed by incision and evacuation of the sac, an operative strategy more anatomically sophisticated than the Ebers § 872 [18]. In China, the *Huangdi Neijing* and, later, Wang Shuhe's *Mai Jing* (Pulse Classic, ca. third century CE) articulate a rich doctrine of the vessels (mai) and of pulse diagnosis, one oriented toward diagnosis and the movement of qi and blood [36].

The chronologic and geographic isolation of Egyptian cardiovascular knowledge from the later Hippocratic and Galenic traditions complicates the question of direct intellectual lineage [5, 31]. Whether Egyptian insights were transmitted to Greek medicine through the Alexandrian school (founded in Egypt in 332 BCE, where Herophilus and Erasistratus later performed the first known human dissections) or whether Greek cardiovascular knowledge developed independently remains a subject of scholarly debate [31, 32]. What is not in doubt, however, is the primacy of the Egyptian contribution: the Ebers Papyrus predates the Hippocratic corpus by roughly a millennium.

The story of cardiovascular surgery thus does not begin with Rehn's suture or Gibbon's pump-oxygenator. It begins on the banks of the Nile, where a civilization uniquely endowed with cultural reverence for the heart, bureaucratic stability, and intellectual curiosity. Modern cardiovascular surgeons, whether repairing a ventricular septal defect or performing a coronary artery bypass, are the inheritors of a tradition whose roots extend millennia into the Egyptian past (Table 1).

Conclusion

Ancient Egypt produced the earliest known treatise on cardiovascular medicine (the Vessel Book of the Ebers Papyrus), the recognition of the pulse as a cardiac diagnostic tool, the oldest known description and surgical treatment of an arterial aneurysm, and a rich paleopathological record confirming the antiquity of atherosclerotic cardiovascular disease. As the discipline continues to advance through ever more sophisticated technologies, it is important to honor the civilization that dared to study, understand, and intervene upon the human heart.

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