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REVIEW

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Anatomy and its importance for surgery in ancient Egypt

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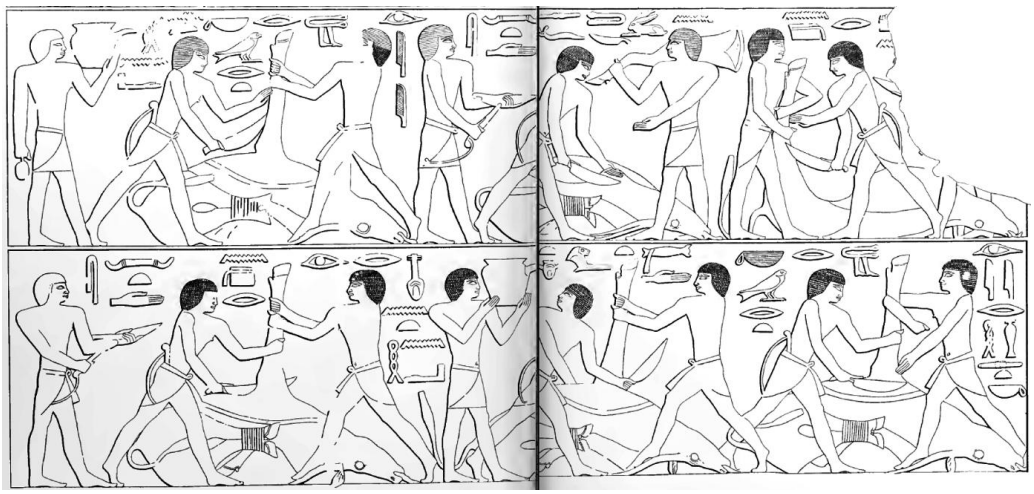
Highlights

It has often been stated that the surgical skills of the ancient Egyptians were based on their considerable anatomical knowledge. However, an analysis of the original sources as well as the modern literature shows little support for this idea. In reality, their anatomical knowledge was quite limited, but more than sufficient for the simple surgical procedures performed.



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Abstract

Ancient Egypt might be considered the cradle of medicine, but the modern literature is often too enthusiastic regarding the ancient Egyptians skills. We often meet the statement that their surgical skills were to a large extent based on their considerable anatomical knowledge. This anatomical knowledge is supposedly demonstrated by their anatomical vocabulary, preserved and lost literary works related to anatomy, the existence of human dissections and knowledge achieved from the mummifications. However, an analysis of the original sources as well as the modern literature provides a rather different picture of the status of anatomy in Ancient Egypt. The medical papyruses demonstrates a rather confused understanding of anatomy and physiology. Even though a considerable number of anatomical terms are known, it is of interest to note that that those dealing with internal anatomy seem to be dependent on animal slaughter. The existence of anatomical books is only mentioned in late works separated by millennia from the period they are describing, and can thus not be trusted. The texts used as support for the existence of human dissections are either incorrectly translated, or are referring to Hellenistic times. Further, it seems likely that lessons from the graves, traumatic injuries and animal slaughter are more important sources of anatomical knowledge than the mummifications, which have little in common with the human dissections performed in Alexandria during the Hellenistic era. The anatomical knowledge of the ancient Egyptians was thus quite limited. However, a very basic anatomical understanding would have been more than sufficient for the simple surgical procedures such as the stitching of wounds, repositioning of fractures and removal of superficial tumors performed in Ancient Egypt.

Keywords: Egypt, Anatomy, Surgery, History

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The author declare that there is no conflict of interest.

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Background

Already at the time of the merging of the Upper and Lower Kingdoms around 3,200 BC, an advanced society existed in Egypt and the birth of the Old Kingdom around 2,686 BC would result in significant achievements in many fields, such as art, architecture, social engineering, and medicine. Concerning medicine, this art might be said to have first seen the light of day in Egypt, at least, this was the opinion of the Egyptians themselves [1].

Egyptian medicine was well respected among its neighbors and Egyptian doctors were sought after by foreign rulers. This high regard for the ancient Egyptians has persisted through the ages, and the Napoleonic expedition to Egypt at the end of the 18th century contributed considerably to the interest, admiration and not least to the romantic air surrounding the alleged skills of the ancient Egyptians, which to some extent still persist today.

However, even if Egypt might be considered as the cradle of medicine, the modern literature is sometimes too enthusiastic. This is perhaps most noticeable regarding the surgical skills which have been attributed to the Egyptians. Such procedures as cataract surgery [2–9], trephinations [10–19], tracheostomies [18, 20–25], oral surgery [26–38], limb amputations [2, 15, 39–42] etc have often, but incorrectly [43–47], been considered of Egyptian origin.

In the modern literature regarding the ancient Egyptians, we often meet the statement that their surgical skills were to a large extent based on their considerable anatomical knowledge. This anatomical knowledge is supposedly demonstrated by their anatomical vocabulary, preserved and lost literary works related to anatomy, the existence of human dissections and knowledge achieved from the mummifications [2, 13, 16, 26, 34, 40, 48–62].

In an attempt to provide a critical and balanced image of the surgical skills of the ancient Egyptians a critical review of the original sources as well as the modern literature regarding the different areas of surgery was necessary.

The aim of the current paper is to briefly present and analyze the primary sources, as well as the modern scientific and scholar literature concerning the anatomical knowledge of the ancient Egyptians.

Books on anatomy

One of the first pharaohs, Athothis (sometimes identified with Djer), is said to have practiced medicine and to have written books on anatomy as early as around 3,000 BC. Iulius-Africanus said: “Athotis, his son, 57 years. He built the palace in Memphis. His books on anatomy are in circulation, for he was a physician [63].” Considering that this information stems from the lost Aegyptica of Manetho from the 3rd century BC [64], written almost 3 millennia later in Greek during the Hellenistic era, it is probably wise not to put any trust in this statement.

Manetho does, however, mentions that these books were still existant in his time, and it is possible that books on anatomy (incorrectly) ascribed to Athothis existed in his days, a not uncommon manner in the old Egypt to give authority to a work. From the field of medicine we can mention the Berlin medical papyrus which is said to have been ancient already when it was found under the feet of Anubis in Letopolis in the 1st dynasty, whereto also a part of papyrus Ebers traces its origin, the London medical papyrus, filled with secret knowledge of the goddess, is claimed to have fallen into the temple court one night during the reign of Khufu in the 4th dynasty [13, 65]. These datings should of course not be taken more seriously than the divine origin.

However, the books ascribed to Athothis might possibly be the same work as was mentioned by Clement of Alexandria some 500 years later. He writes in the Stromata [66] that the Egyptians in a procession carried six books on medicine “treating of the structure of the body, and of diseases, and instruments, and medicines, and about the eyes, and the last about women” forming a part of the 42 books of Hermes Trismegistus. This is however, pure speculation and no works on anatomy have been preserved to posterity. Our knowledge of anatomy in Egypt comes mainly from the medical papyri, especially from the Ebers papyrus [67], and to a lesser degree from the Edwin Smith surgical papyrus [13].

Perhaps the most impressive of the Egyptian understandings of the human physiology was their awareness of the connection between the beating of the heart and the pulse [68]. Concerning other parts of anatomy and physiology the situation is rather confused, which to some extent must be explained by the fact that no investigations of the internal anatomy were performed with the organs in situ, but only when externalized and separated from each other [34]. This is clearly demonstrated regarding the blood vessels. Metu was an important term in the Egyptian anatomy, most readily translated with vessel, but also including other structures such as tendons and muscles. Even though they describe a vascular tree originating in the heart this tree had also a second point of convergence in the anal region. It further seems as if they had an unclear notion of what were blood vessels, and what consisted of other structures, since they considered a number of different substances, such as urin, semen and air to pass through these vessels. Also concerning other aspects of anatomy and physiology their knowledge seems to have been limited, and attributable to what might have been learned from observation of animal slaughter and traumatic injuries [67, 69, 70].

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Dissections/autopsies

The idea that the Egyptians performed dissections/autopsies is based on the above mentioned text by Manetho, some later texts, and some cases in the Edwin Smith papyrus.

Regarding Manethos Egyptica, this work is lost, but fragments of interest were preserved in the Chronographiae by Julius Africanus from the 3rd century AD [63] and the Chronicon by Eusebius from the 4th century AD [71, 72]). The Chronographiae is also lost, but fragments were preserved in the Chronicon, as well as in the Ekloge Chronographias by Syncellus from the 9th century AD [63].

The first part of the Chronicon, which is the only part of interest here, was only preserved in extenso in a later Armenian translation [71, 73, 74]. However, fragments of Manetho were preserved also in the Greek text of Syncellus, who quoted both Julius Africanus and Eusebius in his preserved work [75]. When comparing the fragments of Eusebius from these two sources with Julius Africanus, it is evident that the translation into Armenian has led to some alterations of the content. Based on the above, one would expect Julius Africanus to be closest to the text of Manetho, followed by the Greek text of Eusebius, and last the Armenian translation of the latter.

The Greek text of Julius Africanus [63, 76] and Eusebius [75, 76] are in agreement that Athotis wrote books on anatomy. Only in some translations based on the Armenian version is it stated the he wrote books on autopsies/dissections. [71, 77–79]. *Eusebius Chronicle* recorded: "Athotis, his son, ruled for 27 years. He built a palace in the city of Memphis. He was skilled in medicine, and wrote about how to conduct autopsies [71])." Thus, considering that Manetho was separated by almost 3,000 years from Athotis no trust can be put in this information. However, if we were to put any trust in his statements, then we should of course put more trust in the statement that he wrote books on anatomy, which is stated in the Greek versions of Africanus and Eusebius. The statement that he performed autopsies is evidently a product of the translation.

Two other source sometimes referred to as support for human dissections are Aulus Gellius and Pliny [16]. Aulus Gellius stated that Apion wrote, in his now lost work Aegypytiacorumon, that dissections had been performed in Egypt. The text itself seems, however, to suggest that he is here referring to the Greek period. *The Attic Nights* recorded: "We have been told that the ancient Greeks had a ring upon the last finger but one of the left hand ... That by dissecting and laying open human bodies, as the custom was in Egypt, which the Greeks call anatomy, it was discovered that from that finger only, of which we have spoken, a very fine nerve proceeded and passed quite to the heart [80])."

The case is the same with Pliny, who when describing dissections of the human body, is always referring to Hellenistic times [81]. Pliny said: "…for it has been found by experiment, in Egypt, that the phthiriasis which attaches itself to the internal parts of the heart, cannot possibly be eradicated by any other remedy, the kings of that country having ordered the bodies of the dead to be opened and examined, for the purpose of enquiring into certain diseases. Such, too, is the frivolity of the Greeks, that … [82]". Dissection, and possibly vivisection of humans are well known from the Hellenistic Alexandria, especially regarding Herophilus in the 4th and 3rd century BC [69].

It has further been suggested that the anatomical knowledge displayed in the Edwin Smith papyrus, especially case [33] describing the consequences of a crushed vertebra in the neck necessitates the existence of human autopsies/dissections [83, 84]. *The Edwin Smith Surgical Papyrus* recorded: "If thou examinest a man having a crushed vertebra in his neck (and) thou findest that one vertebra has fallen into the next one, while he is voiceless and cannot speak; his falling head downward has caused that one vertebra crush into the next one; (and) shouldst thou find that he is unconscious of his two arms and his two legs because of it [13]." Unfortunately, no direct support exists for such hypothesis [85]. It is of course not possible to reconstruct the exact manner in which different sources contributed to the anatomical knowledge of the Egyptians, but it seems as if contributions from beyond the grave, animal slaughter and traumatic injuries offer a more simple explanation for this and similar cases.

Lessons from beyond the grave

Concerning the skeletal anatomy, including the spinal column, the inhabitants of the shallow graves in the dessert, often disturbed and unearthed by the elements and by scavengers, must have provided an ample material of study for the interested. A material far more easy accessible, and in the skeletonized state more easy to study and comprehend, than its fleshier counterparts. The same must have been true in slightly less decomposed bodies regarding the ligaments and tendons forming, together with the bones, the movement apparatus. Even if Sushruta advocated the study of the whole anatomy by inspecting the gradually decomposing body (due to cultural taboos), it seems, however, unlikely that much more could be achieved in this manner [86].

Traumatic injuries

Traumatic injuries in wounded and recently dead, obtained in war and peace, would have provided some insight in the internal human anatomy, as well as some glimpses of the function of various parts of the body, as is beautifully demonstrated in case 6 of the Edwin

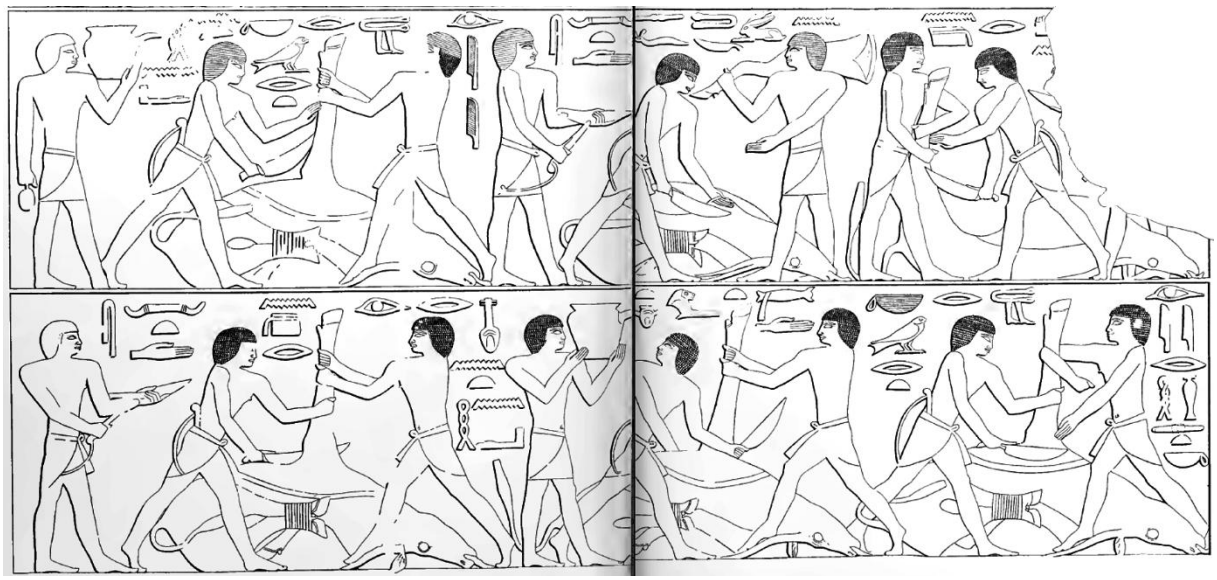

Figure 1 Animal slaughter

Smith papyrus. “Shouldst thou find that smash which is in his skull [like] those corrugations which form in molten copper, (and) something therein throbbing (and) fluttering under thy fingers, like the weak place of an infant's crown before it becomes whole-when it has happened there is no throbbing (and) fluttering under thy fingers until the brain of his (the patient’s) skull is rent open-(and) he discharges blood from both his nostrils, (and) he suffers with stiffness in his neck [13].”

Animal slaughter

Animal slaughter provided an opportunity to study the gross anatomy of the whole body, including the internal organs, their location and connections (Figure 1). Regarding the cases concerning the neck in the Edwin Smith papyrus (cases 29–33), it must have been obvious for those with experience of slaughter that the cervical column restricted the range of movements in the neck. The killing of smaller animals by breaking their neck should also give some understanding of the process. The Egyptians had noticed the homology between animal and human organs, as discussed below.

Gordon et al [87] have pointed out that it is possible that the ritualistic slaughtering of sacrificial animals might have been an important source for anatomical knowledge. At least the educated priesthood taking part in these sacrifices might have been more prone to formulate anatomical/physiological observations, than the village butcher. Whether or not some form of extispicy using the inner organs was practiced in these ceremonies is not known, but several depictions of priests overseeing the slaughter and approving of the animal are known.

Anatomical terminology

The Egyptians demonstrated a rather developed anatomical terminology [88, 89] and some hundred anatomical terms are known, according to Lefebvre 214 [90], mostly regarding external anatomy [89]. The Egyptian terms for external anatomical structures are mostly derived from the human anatomy [34]. However, concerning the internal anatomy Cave has pointed out that the names of the brain, spinal cord, cerebral convolutions, meninges, heart, lung, diaphragm, kidney, bladder, stomach, bowel and uterus were written with animal determinatives, “*thus manifesting their recognition of the homology between human and animal organs*” [89]. The hieroglyphs themselves are in several cases based directly on animal anatomy, as the sign for throat, constituted by the head and trachea of an ox “ ”, or the typical bicornuated bovine uterus “ ”. This would also support the dependence of the early anatomy on animal slaughter, rather than on lessons learned during the mummification [91].

Mummification

The Egyptian texts and illustrations concerning mummification are few and of a ritualistic nature, providing no details about the actual procedure (Figure 2) [92]. Some technical information is, however, provided in later works from the Greek and Roman era [93–96], where The histories of Herodotus [95] from the 5th century BC is the most important. Herodotus described three different methods of embalming, but only the one where an incision was made is of interest

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Figure 2 Embalming scene

here: “First with a crooked iron tool they draw out the brain through the nostrils, extracting it partly thus and partly by pouring in drugs; and after this with a sharp stone of Ethiopia they make a cut along the side and take out the whole contents of the belly, and when they have cleared out the cavity and cleansed it with palm-wine they cleanse it again with spices pounded up: then they fill the belly with pure myrrh pounded up and with cassia and other spices except frankincense, and sew it together again [95].”

Another description is provided in Bibliotheca historica by Diodorus Sicculus [96] from the 1st century BC: “Then the chief among them, (who is called the scribe), having the body laid upon the ground, marks out how much of the left side towards the bowels is to be incised and opened, upon which the Paraschistes, (so by them called), with an Ethiopian stone, dissects so much of the flesh, as by the law is justifiable, and having done it, he forthwith runs away, might and main, and all there present pursue him with execrations, and pelt him with stones, as if he were guilty of some horrid offence, for they look upon him as an hateful person, who wounds and offers violence to the body in that kind, or does it any prejudice whatsoever. But as for those whom they call the Taricheutae, they highly honour them, for they are the priest's companions, and, as sacred persons, are admitted into the temple. As soon as they come to the dissected body, one of the Taricheutae thrusts up his hand through the wound, into the breast of the dead, and draws out all the intestins, but the reins and the heart. Another cleanses all the bowels, and washes them in Phoenician wine, mixed with diverse aromatic spices [96].”

The mummification process displays some variations, both over time and between different mummies from the same period [97]. However, what is of importance regarding the mummification process as a source of anatomical knowledge is that in eviscerated mummies an incision of about 10–15 cm was done in

the left flank (Figure 3) [98], the brain, when removed, was normally done so piecemal through the nose (Figure 4) [99], and during some periods small incisions were also done in the skin to allow subdermal stuffing (Figure 5). [100]

It seems unlikely that the mummifications would have markedly improved the anatomical knowledge of the ancient Egyptians: subdermal incisions would have revealed little concerning the underlying muscular anatomy; piecemeal removal of the brain excluded a gross anatomical view; removal of abdominal and thoracic organs trough a small incision would provide a gross-anatomical view of some of the individual organs, but little information regarding their location, relationship and connections beyond what could be learned from animal slaughter. The mummification was clearly more related to slaughter than to the later systematic dissections performed in Alexandria during the Hellenistic era. Perhaps the most important contribution of frequent mummifications might have been to strengthen the understanding of anatomical homology between species, thus strengthening the motivation for contemplating anatomical observations, regardless of origin [101].

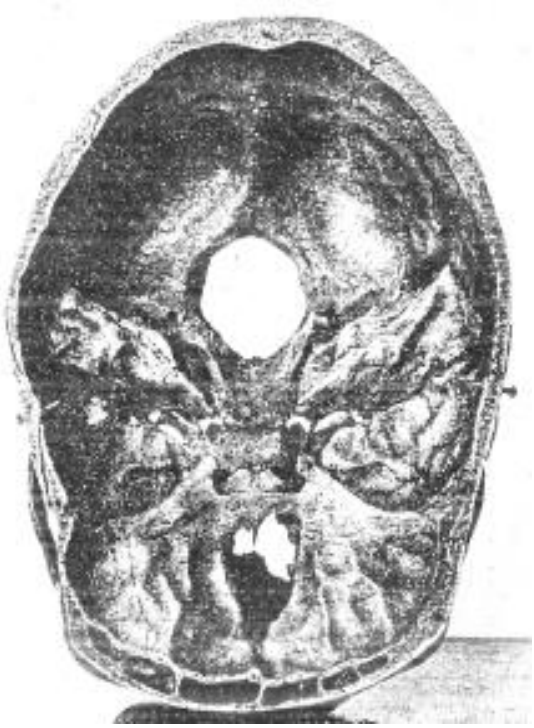

Figure 4 A skull demonstrating a transnasal craniectomy for removal of the brain

Figure 3 Abdominal incision for evisceration

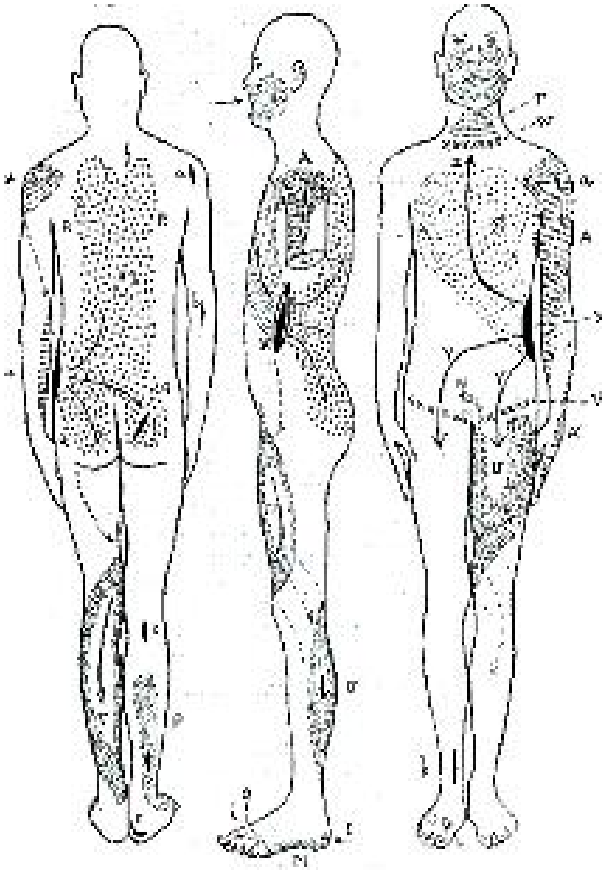

Figure 5 Subdermal stuffing. Lines indicating the incisions and dots the area of dissection/stuffing

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In itself, opening of the human body is not enough to create an understanding of anatomy. Ackerknecht [102] made a comparison between the anatomical knowledge in primitive societies practicing autopsies and those not opening the body, and found them to be equally ignorant of anatomy.

The debt of Egyptian surgery to Egyptian anatomy

We further have to ask if we need to assume a high level of anatomical knowledge in order to explain the level of Egyptian surgery. Egyptian surgery has often been stated to be advanced [26, 48, 57, 58, 67, 103–105], and many major procedures have over the years incorrectly been given an Egyptian origin. In reality, the written sources, depictions, mummy material and other archeological findings provide evidence only for minor surgery [43–47].

The Edwin Smith surgical papyrus is an impressive work with respect to the structured content and the observational skills displayed. However, the term "surgical" is here a better description of the conditions than of the treatments. Here, and in the surgical part of Papyrus Ebers, the surgery is limited to minor procedures such as the stitching of wounds, repositioning of fractures and removal of superficial tumors. Further, in none of more than 30,000 examined mummies have one found a single surgical incision [101].

Thus, a very basic anatomical understanding would have been more than sufficient for the simple surgical procedures performed in Ancient Egypt.

Conclusion

The Ancient Egyptians have in modern publications often been attributed with an extensive anatomical knowledge, of importance for their surgical skills. These statements are most often propagated through the modern literature referring to other modern publications, but without adequate references or analysis of the original sources. A review of the later regarding vocabulary, literary works, dissections and mummifications does, however, reveal the Egyptian anatomy to be at a very basic level. Even so, this level would have been more than adequate for the simple surgical procedures performed in Ancient Egypt. When writing on the history of medicine, relying on secondary sources without consulting the original is not to be recommended.

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