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## Herophilus and vivisection: a re-appraisal

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There were cultural taboos against dissecting dead bodies in both Ancient Greece and Ancient Egypt. Yet in Alexandria under the reigns of Ptolemy I (Soter) and Ptolemy II (Philadelphus) such dissection was carried out by Herophilus and outstanding new knowledge of human anatomy was gained. The original writings of Herophilus no longer exist but they were known to Galen and presumably also to Celsus who lived a century before Galen. Celsus has written a passage in the introduction to his 'De Medicina' in which he describes vivisection undertaken in Alexandria by Herophilus and his own opposition to it. Whether Celsus was relating the facts or just the information available to him has been debated for nearly two millennia. In this paper, certain every day experiences from the operating theatre are presented and it is argued that these experiences make it unlikely that vivisection would be used to demonstrate anatomy.

**Keywords:** *Herophilus, vivisection, dissection, Galen, Alexandria*

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### Introduction

Did Herophilus perform vivisection of criminals due for execution? This has been a topic of debate for nigh on two millennia. One reason for believing that he did is to be found in the writings of Celsus. Celsus is held in almost universal respect and his words carry a great authority. However, the way Celsus presents his information is not entirely straightforward and this taken with general surgical experience has prompted the following article.

### Material and Methods

The information presented in this short article is derived primarily from the works of Quintus Septimius Florens Tertullianus (ca 160 – ca. 225 AD) anglicized to Tertullian and Aulus Cornelius Celsus (ca. 25 BC – ca. 50 AD). They wrote on the topic in Roman times. These texts are supplemented with comments from current analyses of these writings. The views expressed in these contemporary writings are then viewed from the point of view of an experienced surgeon.

### Background

One of the greatest ancient Greek medical scientists was Herophilus of Chalcedon (ca. 335 – 280 BC). He was the first to perform systematic human dissection and described much

cerebral anatomy for the first time. He had been born in Chalcedon, then a small city on the Asian side of the Bosphorus but now Kadiköy a suburb of Istanbul. He went as an adolescent to Cos around 65 years after Hippocrates had died and was taught there by Praxagoras one of Hippocrates followers [1]. At around 300 BC he moved to Alexandria. Before it is possible to proceed to discussing vivisection it is necessary to consider briefly the concept of the soul as perceived by the majority inhabitants of Alexandria in the second century BC, that is to say the Egyptians and the Greeks.

### Ancient Notions of the Soul

#### *Egyptian*

The Egyptians believed that there was a separate immortal soul which survived death. Thus, damage to a corpse could hinder the soul's journey beyond the grave. There were a variety of arguments and procedures which were used to justify mummification within this intellectual framework, but scientific examination of a corpse was forbidden and in consequence the Egyptians gained little knowledge of anatomy [2]. These concepts meant that human dissection was taboo.

#### *Greek*

The Greeks had believed in the separation between body and soul since before the time of Homer (7<sup>th</sup> Century BC). However, the nature of this relationship varied. During the later

evolution of ideas Plato held a dominant place, believing that the soul was immortal and left the body at death to be reunited with some primitive spiritual origin [3, 4]. The Greeks considered any handling of a corpse was unclean and taboo. Thus, the necessary processes associated with the death of a person involved careful regulations and procedures to ensure the retention of cleanliness after contamination from a corpse. This attitude meant that human dissection was taboo [2, 5].

Aristotle (384–322 BC) on the other hand considered the soul to be the essence that animated living matter and that it was mortal and died with the organism that contained it. In the current context this was important because it could mean that Aristotle's authority made the practice of human dissection more acceptable, even if direct evidence to support this notion does not exist [5]. However, if this is a correct interpretation then his ideas would gain added weight in a world dominated by Alexander the Great, since Aristotle had been his tutor.

### *Alexandria*

Alexandria, founded in 331 BC was a city built at the instruction of Alexander the Great ((356 – 323 BC) who was actively involved in its design. It constituted a gateway into Africa and would serve as a base for the Eastern Mediterranean. Alexander the Great died in 323 BC and in the subsequent division of his empire, one of his generals also a Macedonian, Ptolemy (367 – 283 BC) later called Soter or Savior got Egypt. His reign started in 323 BC 8 years after the foundation of the city. While running his own life in accordance with Greek principles and norms he was wise enough to acknowledge the religion of his subjects. He started a dynasty which survived somewhat over 300 years to the time of the Roman Empire. In the academic literature there is argument about what he did and how much value it had but certain elements of his reign are broadly agreed. He acquired the body of Alexander the Great, brought it to Egypt and had it transferred to Alexandria where it lay in a sarcophagus and was visible to all. This added to his prestige and the authority of his rule. Moreover, during his reign the famous museum and library were founded. Some say the design of the library and its catalogue system was based on the system used by Aristotle [5]. Even though there is no certain

evidence this is true it is not inconceivable, though it is not all that important. On the other hand it is most important that the foundation of the most distinguished university of the Hellenic world took place in Ptolemy Soter's city and during his reign [6]. Moreover, his work was continued by his son Ptolemy 2 – called Philadelphus (Brother loving) (309BC – 246 BC). It is tempting to believe that what occurred in Alexandria at that time is a parallel of the Elizabethan era, the English Restoration or the establishment of the constitution of the United States of America. For unknown reasons, it infrequently happens that a group of men of genius appear in the same place and at the same time to produce intellectual advances of unforeseen beauty and power. In general terms we have Aristotle's possible influence mediated via Alexander the great to his satrap Ptolemy during whose reign the greatest university of Hellenic times (the museum and the library) was founded. Add to this the genius of other great minds in the Alexandria of the time who include Euclid and Archimedes but also Herophilus of Chalcedon [5] and Erasistratus of Ceos (304BC – 250BC) and it does seem plausible that in Alexandria at the time under advisement there was one of these rare concentrations of talent.

### *Human Dissection*

Uniquely for the ancient world, there was a short period in Alexandria where human dissection was permitted. Since this went against the grain of all practice before and after the few decades when it was permitted, there had to have been a reason that it arose when it did and where it did. In general it is seen to have been stimulated by both Ptolemy 1 and his son Ptolemy 2. They are said to have licensed the practice, provided the corpses of criminals to enable the practice and indeed it is stated that Pliny recorded that the pharaohs came to observe [7]. Thus, there was stimulus from above and at the working level there was the genius anatomist Herophilus who had been attracted to this prime academic center which the efforts of these pharaohs had produced [7]. Heinrich von Staden points out that there is no evidence that Herophilus practiced at the museum itself [8, p. 138–241]. However, von Staden states the probable reason for dissection in Alexandria most succinctly “*The unusual combination of ambitious Macedonian patrons of*

science (i.e. the Ptolemies), eager scientists like Herophilus, a new city in which traditional values were not intrinsically superior, and a cosmopolitan intelligentsia committed not only to literary and political but also to scientific frontiersmanship, apparently made it possible to overcome traditional inhibitions against opening the human body.”[8, p. 138–241] Also, while he does not specify it in the current context a further influence for starting dissection at this time and place could have been the example of Aristotle as mentioned above.

## Vivisection and Herophilus

### Documentation

There is plenty of evidence that Herophilus performed dissection on adult human corpses [1, 5, 7; 8, p. 138–241; 9, p. 41; 10]. This was a complete departure from accepted practice as outlined above. However, it only lasted for 30 to 40 years. This detail of limited duration is important [1, 5; 8, p. 138–241]. It is considered that the rise of the Empiric school in Alexandria after the death of Herophilus and Erasistratus (304 – 250 BC) militated against the continuation of human dissection and facilitated the return of the treatment of corpses to earlier norms [1, 5; 8, p. 138–241]. Their second patron Ptolemy 2 (Philadelphus) died shortly after Erasistratus. Ptolemy 2 was succeeded by Ptolemy 3 Euergetes (Benefactor). His date of birth is not known but he reigned from 246BC to 221BC. It is not known if he was less interested in the science of dissection or whether there was no anatomist of sufficient enthusiasm to continue with it. It is also possible that opposition from the priestly class may have played an increasing part in discontinuing what they would have considered an abomination. It is relevant that part of the style of Ptolemaic government was to stay on the right side of at least the more powerful priests; for example those from Memphis [11]. Nonetheless, to interpret Ptolemy 3’s attitudes in the light of existing documentation is speculation.

The main arguments supporting the notion that Herophilus performed vivisection as opposed to human dissection come from the introduction to Celsus’ ‘De Medicina’ [9, p. 15]. There are no surviving writings of Herophilus so that accounts of him are based on the writings of others amongst whom Celsus is pre-eminent. Another person who

is said to have had access to all Herophilus’ writings was Galen (130 – 210 AD) [12] who comments on him positively but only on his anatomy and not on his methodology. Further mention of Galen’s role will be taken up later. Firstly, it is necessary to consider what Celsus wrote.

Celsus’ reporting is generally accepted because of respect for his character and for the quality of his writing [8, p. 138–241]. He mentions vivisection in the introduction to his De Medicina in the context of explaining the different views of different medical philosophies. Nonetheless, he was writing over 200 years after the events in question. He includes the above mentioned empiricists who believed personal experience in the treatment of disease was an adequate basis for a physician. They disagreed totally with the dogmatists who believed it was necessary to know the hidden causes of diseases, a belief which included knowledge of internal anatomy. Herophilus was in agreement with this view.

Celsus while describing the notions of the dogmatic school states amongst other things the following about its members. “*Moreover, as pains, and also various kinds of diseases, arise in the more internal parts, they hold that no one can apply remedies for these who is ignorant about the parts themselves; hence it becomes necessary to lay open the bodies of the dead and to scrutinize their viscera and intestines. They hold that Herophilus and Erasistratus did this in the best way by far, when they laid open men whilst alive – criminals received out prison from the kings – and whilst these were still breathing, observed parts which beforehand nature had concealed, their position, colour, shape, size, arrangement, hardness, softness, smoothness, relation, processes and depressions of each, and whether any part is inserted into or is received into another.*”[9, p. 15] This is Celsus quoting the opinions of others not his own. Despite the respect in which Celsus is held the passage does contain at least one oddity. That is the phrase “It becomes necessary to lay open the bodies of the dead”. Since human dissection had been carried out for only 30 to 40 years in Alexandria and been thereafter banned as it had been before, this is a strange remark. However, it could make sense if it were a quotation from dogmatic writers contemporary with Herophilus and Erasistratus. Celsus lived over 200 years after Herophilus.

Later in the same passage there is a justification for accepting the cruelty of vivisection. “*Nor is it, as most people say, cruel that in the execution of criminals, and but a few of them, we should seek remedies for innocent people of all future ages.*” [9, p. 15]” This is also in keeping with a quotation from a source which is propaganda for a particular point of view. In other words, if it may be accepted that what Celsus is writing is not a factual record but a repetition from an earlier document written by people deeply committed to a particular pattern of practice, it does raise the question as to how reliable the contents of the text really is.

There is one other slightly strange element to consider. If Galen had as noted above access to Herophilus’ writings they should presumably have been accessible to Celsus who lived roughly a hundred years before Galen. Yet there is no mention of these writings by Celsus only of the views of the dogmatists.

The other source concerning Herophilus and his supposed evil deeds is Tertullian who was a young contemporary of Galen. Tertullian was most concerned with dissection to improve the understanding of God’s handiwork, which was to him a blasphemous presumption. He wrote “*There is that Herophilus, the well-known surgeon, or (as I may almost call him) butcher, who cut up no end of persons, in order to investigate the secrets of nature, who ruthlessly handled human creatures to discover (their form and make): I have my doubts whether he succeeded in clearly exploring all the internal parts of their structure, since death itself changes and disturbs the natural functions of life, especially when the death is not a natural one, but such as must cause irregularity and error amidst the very processes of dissection.*” [10]. This is taken to be a comment on and condemnation of vivisection [8, p. 235–236; 13]. However, it is very close to Celsus’ account of the view of the empirics. “*...since the most things are altered in the dead, some hold that even dissection of the dead is unnecessary; although not cruel it is none the less nasty.*” One could be forgiven for thinking that Tertullian is using either Celsus or Celsus’ source as a source. Tertullian’s language is more extreme than Celsus but this is in keeping with the passion of a Christian apologist who wrote about activities which were for him blasphemous.

It should be emphasized that in keeping with

the opinion of the eminent scholar Henrich von Staden, there is no suggestion that the texts of Celsus and Tertullian are in any way inaccurate. The question is rather, was Celsus writing about facts or was he in all sincerity repeating the opinions of others who might have been biased in their reporting. Nonetheless, it is interesting that the conclusions of Celsus and Tertullian were diametrically opposed. Celsus clearly believed that the Alexandrians had performed vivisection as in the conclusion to his introduction he states “*But to lay open the bodies of men whilst still alive is as cruel as it is needless; that of the dead is a necessity for learners, who should know positions and relations, which the dead body exhibits better than does a living and wounded man.*” [9, p. 41] Thus Celsus supports the practice of dissection undertaken for a mere 40 years in Alexandria two centuries before his own time. Tertullian was opposed to any form of dissection.

Over and above the textual evidence there have been arguments based on recent assessments of the behavior, values and realities of Hellenic culture in the 3<sup>rd</sup> and 2<sup>nd</sup> centuries BC. In particular G.E.R. Lloyd quoted by von Staden has written that “*For all the ancients’ respect for the dead, corpses were desecrated often enough by people other than scientists. Moreover, when we reflect the ancients regularly tortured slaves in public in the law courts in order to extract evidence from them, and that Galen, for example, records cases where new poisons were tried out on convicts to test their effects, it is not too difficult to believe that the Ptolemies permitted vivisections to be practiced on condemned criminals.*” [8, p. 138–241] This would also be in keeping with the apologia for such practice recounted by Celsus above [9, p. 15]. Interestingly, Tertullian does not comment on the cruelty of vivisection, only the blasphemous arrogance of the dissector. It is Celsus who proposes avoiding cruelty. This is an argument one can accept or deny but it is at the end of the day nothing more than an argument.

Another argument put forward to suggest that vivisection would be acceptable was the well accepted practice of vivisectioning animals. If this were a valid argument it is strange that while vivisection of animals occurred from at least the time of Aristotle to at least the time of Galen, the vivisection of humans was limited to



40 years. Moreover, the argument is based on a false premise. The point is that vivisection of animals was mostly done to examine function not structure. For the experiments to work, trauma would be kept to a minimum and would likely involve as small a wound of access and as limited a dissection as possible. This is quite different from the demonstration of anatomy which requires a wide opening. And there can be no doubt that this is what the human vivisection was about as shown in the quotation from Celsus above.

Then there is the matter of Galen's silence on Herophilus and vivisection. He is said to have had all the manuscripts of Herophilus and greatly admired him [7, 12]. For any practising surgeon, available techniques of dissection would be of paramount importance. Had there been vivisection it is hard to believe he would not have mentioned a detail which would have been so important to him [1, 7, 12]. Indeed, two authors report that Galen specifically states that Erasistratus could not have performed vivisection, although the Galenic text concerned is not completely convincing [7, 12]. However, this does serve to emphasize Galen's natural awareness of vivisection. It should be remembered his sole access to human anatomy was gained from wounded gladiators and a couple of skeletons which he would have seen when he visited Alexandria [7].

### ***Surgical Reality***

The passage in Celsus quoted above makes it clear that the purpose of vivisection as described is the demonstration of anatomy. It would involve a wide opening and extensive dissection. If this is what really was undertaken, the procedure could be described as not so much improbable as downright foolish. Any surgeon will know that during an operation under general anesthesia, if the anesthetic becomes lighter or the muscle relaxants used to keep the patient still during surgery begin to wear off, even a little, the patient may start to breathe against the ventilator. This increases central venous pressure and the consequence is that the operating field disappears under a sea of blood. It is believable that if a criminal's body were to be incised and opened against his will the criminal would protest. Criminals are not known for their dedication to the public good especially as this would be

a situation where there was no profit for the sufferer. So the idea that such a one would lie still and relaxed while being tortured is hard to accept. It seems more probable that he would shout, scream and struggle all of which actions would result in increases in central venous pressure and hemorrhage into the area being demonstrated. Moreover, no matter how inured the ancients were to suffering in certain specific situations, as outlined by Lloyd above, in the dissecting room it seems possible that the reactions of the tormented individual would have a distressing effect on the audience. This is not just an idle fancy. Lloyd records that Galen recommended using a pig or a goat for an operation in which the brain is exposed in the living animal in part to "*avoid seeing the unpleasing expression of the ape when it is being vivisected*" [14]. This gives a good indication of the sensibilities of a man who would be far more used to brutality, blood and the knife than would the observers of dissection in Alexandria.

If we are to accept that Herophilus undertook vivisection to demonstrate anatomy it would mean that not only was he cruel and brutal but also less than intelligent, since the procedure would hide what he wanted to demonstrate. This author finds it difficult to accept such a premise.

### **Discussion**

This report has obvious limitations. The author speaks neither Latin nor Greek and is dependent on the scholarship of those who can. However, there is no reason to cast doubt on the extensive painstaking effort which has resulted in the texts which have been used to assess the contents of this paper. The subject is not one where certainty is possible. However, it is suggested that everyday medical knowledge has not been included in previous interpretations of Celsus text and it is the Celsus text which is crucial. Tertullian was a zealot and seems to have used either Celsus or the same sources as Celsus on which to base his critique of Herophilus. Moreover, Tertullian seems surprisingly to have been relatively little concerned with vivisection as opposed to dissection.

It is very difficult to criticize or disagree with Celsus. This author has elsewhere acknowledged the clarity and good sense of his advice about surgical practice. The method he described for the treatment of depressed fractures was hardly

improved until the beginning of the 20<sup>th</sup> century [15]. Nonetheless, Celsus wrote about vivisection only to describe the different points of view of different schools of medical thought. He does not quote Herophilus himself. While all Herophilus work is lost it is thought to have been available for Galen [12] who also does not mention vivisection. This is most strange since Galen was clearly aware of the advantages available to those who could undertake human dissection. He would surely have mentioned vivisection if that had been an element in Herophilus' methodology.

### Conclusion

Interpretations of text and contemporary customs must always remain open to debate and there is no suggestion here that the above

outlined analysis is more than a fresh view on an old problem. It will doubtless and rightly be contested and opposed. However, practical surgical reality does not change from generation to generation or from culture to culture. The current paper suggests that vivisection as a method of anatomical demonstration would be self-defeating as the anatomy would inevitably disappear under a sea of blood for as long as the victim remained alive. It is proposed that this practical phenomenon could be considered to trump all academic discussion. If this is found to be acceptable reasoning then it is suggested that it is highly unlikely that Herophilus performed the vivisection for which he has been blamed and that he has deserved better of his successors than he has so far received.

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