

A second (understandable) error by Aristotle in comparing the location of the human left kidney with that of a cow



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ABSTRACT

Introduction: Aristotle's writings on medical topics remained unchallenged for almost 2000 years. It was Vesalius, in his monumental work *De humani corporis fabrica*, published in the 16th century, who wrote that *sometimes* the left kidney was higher than the right, contradicting Aristotle and Galen. In this paper, we trace another mistake, again by Aristotle, on the location of the kidneys.

Material and Method: We carefully read the Aristotle's writings concerning the location of each kidney of a cow in each site of the back bone and his extrapolation that this is also true for the humans. We then studied references from current zoological articles about the location of the kidneys in a living cow. Based on clinical examinations and laboratory findings, it was shown that both kidneys are located in the right side of the animal, because the rumen part of its stomach pushes the left kidney to the right of the backbone. When the animal is slaughtered or after fasting, the rumen deflates; thus the left kidney returns back to its normal side.

Conclusion: As Aristotle studied dead animals, he was right in his observation but absolutely wrong when interpreting it as applying to a living cow, a human and to all other species.

KEYWORDS: Aristotle and the location of the kidneys, Vesalius and the kidneys, Autopsies in Byzantium, Vivisection

Introduction

This paper is divided in two parts. The first elaborates on Aristotle's (and Galen's) first error concerning the location of the kidneys. The second discusses the arguments about a second, (but understandable) error concerning again the location of the kidneys and represents the novel contribution of the current work to the History of Nephrology.

Aristotle's writings on medical topics were unchallenged for almost 2000 years. It was Vesalius, in his monumental and revolutionary work *De humani corporis fabrica* published in the 16th century who critically noted Galen's ideas (and indirectly Aristotle's, which Galen repeated) about the location of the kidneys. This delay in directly examining Aristotle's thesis is rather strange, as Aristotle himself challenged the method of teaching biological sciences based on theories. He strongly suggested using direct observation via experiments and dissections and opposed the squeamish aversion to them: "(...) even in the study of animals unattractive to the senses, the nature that fashioned them offers immeasurable pleasures in the same way to those who can learn the causes (aitias) and are naturally lovers of wisdom (philosophoi). . . Therefore, we must avoid a childish distaste for examining the less valued animals (1). Similarly, Galen challenged his students and anyone else to conduct the same experiments in order to check the accuracy of his observations. "For I have already shown thousands of times the twin (organs) that intercede the spermatic cords from the outer horns to the inside of the uterus (...). And this must be shown by anyone (that follows the same experimental method) after I and my pupils have died" (2). There is a great irony in Galen's (and Aristotle's) posthumous fate. Although they actively encouraged experimentation and the questioning of

established theory, those who followed were prohibited from questioning their work (3). Both had claimed that the right kidney is higher than the left as they were in dissected animals, mainly the Rhesus Monkey, where this is the case (4). Nevertheless, Vesalius dared to challenge these giants and tentatively introduced the idea that – contrary to Aristotle's and Galen's claims – (5, 6) the left kidney might in some cases be higher than the right, particularly if an enlarged liver pushed the right kidney down. However, he went halfway through as in the first three Tabulae and the relevant figures in the *Fabrica* and the *Epitome* show the right kidney higher than the left. Apparently, he made the blocks before he dissected a human (7). Albeit mild, this refutation was considered a sacrilege. His main critic was his previous mentor Jacques Dubois (1478 – 14 January 1555), also known as Jacobus Sylvius in Latin. As had happened with Aristotle, Galen and their followers, Sylvius' works presented the same contradiction, with the difference that he himself had a rather contradictory stance on the value of direct examinations. On one hand, he urged his students to learn from dissection rather than just from lectures or books. In his textbook *Manual of Anatomy* (1555), he wrote the following in the Introduction:

"I would have you look carefully and recognize by eye when you are attending dissections or when you see anyone else who may be better supplied with instruments than yourself. For my judgment is that it is much better that you should learn the manner of cutting by eye and touch than by reading and listening" (8). On the other hand, when confronted with an observable fact that contradicted Galen, J. Sylvius went so far as to claim that the human body had changed over the centuries, accounting for the dissimilarity (9). In spite of the strong criticism, Vesalius managed to find a prominent publisher,

Johanes Oporinus in Brussels, who printed his renowned book "On the Structure of Man" where he presented his "heretic" ideas (10). However, soon after the *Fabrica* publication, Vesalius was invited to become imperial physician to the court of Emperor Charles V.

After the abdication of the Emperor, Vesalius continued at court, in great favour with his son Philip II. In 1555, he published a revised edition of *De humani corporis fabrica*, in which he was more definite about the location of the right kidney in a lower than the left place (11). The admirers of this book again laudant it stronger than the author himself, thus they did not realize that Galen is both the hero and the villain of the *Fabrica*. His errors are carefully noted, yet the substantial borrowings Vesalius made from him are passed over in silence. (...) Likewise, a few of Vesalius's friends and colleagues are mentioned, and the occasional enemy, but the work of other Renaissance no mention. Hence Vesalius' originality is magnified through his failure to adequately acknowledge his predecessors or competitors (12). One of their claims was that Vesalius through the *Fabrica* was the first modern anatomist who based his anatomical descriptions on personal observation (11), avoiding to face the well-documented fact that dissection started at least 300 years before Vesalius in Italy (13). Another fact, almost ignored by medical historians, is the practice of dissections in Byzantium. It should be emphasized here that it was widespread there for medical reasons (14) – at least two centuries before Italy and half a millennium before Vesalius (15). Two relevant passages are presented: Symeon the Theologian (949–1022 AD) noted approbatively that **doctors both in the past and in the present investigated illnesses by cutting open corpses** "in order to study the structure of the body, and by so doing they would understand the internal construction of living men and endeavor to cure the sickness concealed within" (16). Again, Georgios Tornikes commented on the practice of dissection in his eulogy of Anna Comnena. He described how the doctors separated every organ from its neighbour in order to study its position, form, and parts and to understand its function in relation to other organs. This study, observed Tornikes, allowed a doctor to appreciate how a particular organ was affected or even destroyed when other sections of the body were diseased (17), as referred by Herrin (18). A much earlier but circumstantial practice of autopsy in Constantinople during the 543 Pestis Pandemic is described by Procopius (19).

It is interesting that the whole argumentation in Vesalius' writings is spiced with comparisons and examples from daily life (20, 21). The use of metaphors to highlight medical topics is not an idea exclusive to Vesalius. Long before him and long after, this was the norm. We present a similar passage by Galen and two passages from famous Byzantine authors, and another one by William Harvey, characteristic of the method. Galen's passage compares the veins of the body with the channels gardeners dig in gardens. He argues that like the water from these channels reaches near the plants and then waters them and transfers the vital nutrients via perfusion, so does the blood carried by the veins reach near muscles etc., nourishing them via perfusion (22). The first Byzantine passage is by Eustathios the Monk, a clergyman and medical doctor. He is placed in the ninth century, although nothing can conclusively justify this. We quote: "The creative or better yet the guardian nature, (...) in caring for the animal, it created channeling pores through which the waste and muddy substances of the body are purified. Because as it knew that food is on the one hand useful to the body but also has wasteful elements, for this reason it invented these (pores) just as they who care for the cities, build sewers and streams, so that whatever waste material is collected it can be eliminated into lakes, rivers or seas" (23). The second

passage is by Eustathios of Thessaloniki, a Bishop and Literatus (1115 – 1195/6): "That monarchy is a good (regime) is proved by the celestial order which is governed by one guardian, the Almighty, (...) one is the sun which is awarded to inspect the Earth during the whole day, and one is the moon that is the eye of the night, and the king of kings (God) established one king in our castle, the brain (24). William Harvey, (1578, 1657), similarly wrote in the dedication to the king in his most important book, *De Motu Cordis* (1628) "Most serene King! The animal's heart is the basis of its life, its chief member, the sun of its microcosm; on the heart all its activity depends, from the heart all its liveliness and strength arise. Equally is the king the basis of his kingdoms, the sun of his microcosm, the heart of the state; from him all power arises and all grace stems" (25). In spite of the previous idyllic descriptions, we find two harsh real practices in anatomical research. The first is the use of criminals – dead, alive or in-between – as experimental objects. Writing circa 30 AD, the Roman medical author Celsus stated in the prologue to his book *On Medicine*: "Consequently, it is necessary to dissect dead bodies and examine their viscera and intestines. Herophilus and Erasistratus adopted the best method. They dissected criminals, received from the kings out of prison, and contemplated even while the breath still remained those things that nature had before concealed" (26). Relatively, Tertullian, the Church Father, in his treatise "On the Soul" wrote: "(Herophilus) that doctor, or rather butcher, who cut up innumerable human beings so that he could investigate nature". Although it is debatable that Galen ever dissected humans, he lamented the fact that he had no access to bodies of criminals dispensed by higher authorities. He regretted his refusing to join the Roman campaign against the Germans as the emperor had permitted the dissection of slain enemies. Mattern stresses that: "There can be no doubt that if he had known he would be allowed to dissect a human, he would have braved the perils and discomforts of the campaign and endured the importunities of the emperor." As for his colleagues, fortunate enough to have dissected German corpses, Galen showed only scorn. "They 'did not learn more than butchers know' (27). The Byzantine writer Theophanes the Confessor (9th cent. AD) wrote about Christianus, a robber who had his feet and arms mutilated while still alive, who was given to doctors to be vivisected "to learn the structure of the body" (15). In Italy during the Late Middle Ages and Early Renaissance, the practice of dissection was essentially punitive. Restricted to the cadavers of condemned criminals, the anatomist was seen as the first cousin of executioners and torturers (14). Vesalius snatched the bodies of recently deceased criminals or laypeople using lawful or frequently unlawful methods and then describing them in detail (28). In his Letter on the China Root (1546), Vesalius wrote: "I shall no longer bother to petition the judges to delay an execution to a time suitable for dissection, nor shall I advise the students to observe where someone has been buried or urge them to make note of the diseases of their teachers" (28). He deleted from the revised edition of the *Fabrica* (1555) some of the more lurid passages concerning his quest for cadavers (28). The second garish practice was common to all anatomists and to Vesalius who was proud to illustrate them in his book. For example, the capital letter "O" (in the chapter on the kidneys representing the organ) of the 1543 edition depicted the method of boiling bodies to extract bones. Three angels are carrying the head of an executed criminal (29), the major source of Vesalius' material (30) to the cauldron. Since then, innumerable experiments using the bodies of outcasts and studies thereon took place and the literature is vast. Indicatively, we cite here the amputations of hundreds of legs from inmates in German concentration camps to be transplanted either in situ or days later and many kilometers

away into wounded German soldiers (31). This kind of irreverent approach to human bodies is still followed. Just this month (October 2017), Reuters published the story of Cody Saunders, who was born in 1992 in Tennessee, USA and died on his 24th birthday, after being dialyzed due to kidney failure for many years. His body was given to the company Restore Life to forward it to institutions *“for scientific research”*. In reality, his spinal cord was sold for 300 dollars via email to Brian Grow, an undercover Reuters journalist. He later bought two human heads from the same company. Restore Life’s clients include many respectable medical institutions (32). Hence, we may reluctantly assume that medicine progresses in a pattern of *destructive construction*.

Having discussed Vesalius, his era and the conditions under which he traced Aristotle’s first error, we now present another mistake we traced made by Aristotle, similarly on the location of the kidneys. He had also made other mistakes about the kidneys but this is beyond the scope of this article (33). It is understandable that our attempt to correct the Philosopher could once again be considered sacrilege but we are encouraged by his own statement that: *“(…) for an educated man should be able to form a fair off-hand judgment as to the goodness or badness of the method used by a professor in his exposition”* (34).

Material and method

We read carefully the Aristotle’s writings concerning the kidneys’ location in the body. The relevant passages are: A) *“After these organs come the ‘kidneys’, and these are placed close to the backbone, and resemble in character the same organ in kine”* (Medieval English for the cow) In all animals that are provided with this organ, the right kidney is situated higher up than the other (35). B) *“(…) and these viscera-the liver and spleen on either side with the kidneys behind-attach the great vessel to the body with the firmness of nails. The aorta sends similar branches to each kidney, but none to the liver or spleen”* (34). C) *“(…) and the kidneys also lie in the same position in all creatures that possess them”* (35). We then studied references from current zoological articles about the location of the kidneys inside a living cow, and discussed the topic with two emeriti Professors of Veterinary Anatomy (the one having served as Dean) in the School of Veterinary Medicine at the Aristotle (*sic!*) University of Thessaloniki in Northern Greece.

Results

Our findings were surprising. We quote: *“The kidneys of the bovine do not lose their foetal lobulation (...) the right ureter leaves the kidney and passes along the roof of the abdomen to the pelvis in a fairly standard pattern. The left ureter however moves across the dorsal surface of its kidney to return to the midline and follow a course as if the kidney was located on the left (Both kidneys in the bovine are located on the right)* (emphasis by the author of this article) (...). The left kidney in the bovine is found caudoventrally to the right one usually in the region between the 2nd and 4th lumbar vertebrae (36). It is situated in the midline almost directly above the rectum and should be easily palpable – check that the lobules are distinct and that the kidney is of a normal size (37). Similarly, in a rectal examination *“(…) at the right of the rumen in the midline area is the left kidney...”* (38). With U/S the left kidney could not be seen from the left paralumbar fossa, but it was imaged in its entirety from the right paralumbar fossa in all the cows (39).

The left kidney hangs low on a well-developed mesentery (...) Only if it is pushed to the right of the midline by the rumen can it be imaged caudal to the right kidney (40). The apparent anomaly is explained by the fact that the stomach of the cow includes the rumen or paunch, reticulum or “honeycomb”, the omasum or “manyplies” and the abomasum or “true stomach”. The rumen (on the left side of the animal) is the largest of four compartments. It can hold 25 gallons or more of material, depending on the size of the cow (41). Consequently, it pushes the left kidney to the right of the backbone (42). When the animal is slaughtered or after fasting, the rumen deflates; thus the left kidney returns back to its normal side. It is interesting to add that in spite of the vast bibliography, the notion that the left kidney of a cow may be located on the right did not gain wide support. When discussing the matter with the aforementioned professors of Zoology, they blandly refused to accept the fact and were rather derisive. This ignorance could be expected in an era before the modern diagnostic techniques when even specialized articles were repeating the notion that the kidneys of a cow are situated on each site of the back-bone (43). Similarly, as Aristotle was studying dead animals, he was right in his observation but absolutely wrong when interpreting it as applying to a living cow and even to all species. This kind of extrapolation was proposed later by Galen in the treatise *“On the Natural Faculties: “(…) but practically every butcher is aware of this, from the fact that he daily observes both the position of the kidneys (...) and from this arrangement he infers their characteristic use and faculty”* (44). The butcher is a recurrent feature in Anatomy treatises in the past. Simultaneously with Galen, Tertullian, to whom we referred earlier, had a more acute foresight: *“I have my doubts whether he (Herophilus) 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”* (45). Vesalius himself noted: *“And thus all things are taught wrongly, and days go by in futile disputations. Fewer facts are placed before the spectators in that tumult than a butcher could teach a doctor in his meat market* (46). Aristotle’s error could have been prevented even by his own ideas, as elsewhere he wrote that: *“(…) and they are led into their error by their observation of lungs removed from animals under dissection, out of which organs the blood had all escaped immediately after death”* (47).

Conclusions

We notice the vitae parallelae of Vesalius and Galen. Both had been military doctors, following the imperial armies’ campaign and gaining experience by treating battle wounds. Both had been Royal Doctors. Similarly, Aristotle was the tutor of Alexander the Great, making clear that a high patronage was – and may be still is – essential for the promotion of research and the researchers themselves. In addition, all were only too happy to use – if they could – the corpses of executed criminals for their anatomical studies, commenting scornfully on the butchers’ works. All three had used dissections to understand Nature better. Aristotle’s second error on the location of the human left kidney compared to the cow’s is due to the fact that he could study a cow’s internal organs only when it was dead, not having at his disposal the high-tech means we have today to study the animal while alive, without any incisions.

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