

Depictions of the Kidney through the Ages

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Key Words

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Abstract

Recent publications [*American Journal of Nephrology* (1985-1995)] have contributed much to our understanding of the history of nephrology. Whether the earliest medical knowledge of the kidney was kindled in Egypt, by the Hindus in India, in ancient China, or by [Assyro-Babylonians](#) we cannot determine with certainty. What is known is that the invention of the printing press (circa 1450 AD), with the subsequent availability of translations of earlier writings plus new text editions, contributed in prodigious measure to the development of the critical and questioning character of medicine. The availability of different book illustration techniques also contributed to the development of medical knowledge. We have examined major descriptions of the kidney in 16th-, 17th- and 18th-century original works, all held by the Becker Medical Library, Washington University. The accuracy of illustrations of the observed kidney was highly variable, but each description has its place in book and 'kidney' history.

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Although this work will focus on the kidney, it seems only appropriate to initially make some mention of the final product of the kidney, urine. Homer W. Smith began his writing of *De Urina*, the history of the study of urine and its contribution to medical science and philosophy, with a delightful quotation from Isak Dinesen's *Seven Gothic Tales*. One of her characters speculates, 'What is man, when you come to think upon him, but a minutely set, ingenious machine for turning, with infinite artfulness, the red wine of Shiraz into urine?' [1]. In his lecture, Smith then developed the importance of urine in the history of medicine, citing the significance of urine examination to discoveries in chemistry, physiology and to healing. He concluded that in large measure man is what he is because his urine is what it is. Physicians have collected, examined and recorded their findings related to urine since antiquity; however, recognition of the importance of the kidney is itself a relatively recent event, and ancient depictions of this organ are scarce. Whether this was due to the fact that kidneys were not visualized because of their retroperitoneal location, or whether they were regarded as less important organs than the liver, heart, lungs and intestines (which were recognized by the ancients as suitable organs from sacrificed animals to be offered as gifts to the various deities), we do not know. The existence of kidneys certainly was known, for they would have been seen in slaughtered animals, and names for urine and kidney appear in Sumerian writings (3500-3000 BC) [2].

Votive offerings found at archeological excavations of the ancient Greek and Roman civilizations provide us with some of the earliest representations of the kidney. These articles, in

clay, stone, marble or precious metals, depict parts of the body for which cures were sought or had been obtained. Though replicas of a number of organs and limbs (hearts, uteri, arms, legs) have been recovered with some regularity at these sites, such reproductions of the kidney are extremely rare. What is thought to be the oldest (13th century BC) votive offering of the kidney (fig. 1a) is a bronze figure found in the Kition temples in Cyprus [3]. Another is a circa 3rd-century BC terra-cotta figure of a kidney (fig. 1b) found at Capua on the ancient Appian Way [4]. The present study will address 16th-, 17th- and 18th-century depictions of the kidney. Most of these illustrations are obtained from original rare books available in the Bernard Becker Medical Library of Washington University. We will discuss classic giants of nephrology and anatomy as well as lesser-known authors.

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Fig. 1. a, b Votive figures of a kidney, a A 13th-century BC bronze, found at Kition in Cyprus [reproduced with permission from ref. 3]. b Roman terra-cotta, found at Capua on the Appian Way [reproduced with permission from ref. 4].

Fig. 2. Vesalius' depiction of the human kidney in his *Fabrica* (p. 372) showing the right kidney positioned higher than the left [reproduced from ref. 5].

Illustrated manuscripts were certainly known, and circulated to a limited extent, in the medieval civilized world. However, it was the printing press (circa 1450) and the introduction of movable type which fostered the rapid growth of all genres of literature. Initially, woodblocks were used to produce illustrations, while by the late 16th century, copper engravings were introduced into book illustration.

Along with the development of surgery in the medieval and Renaissance periods, there was the necessity to improve the status of human anatomy. Medical illustrations were usually done by artists, who perhaps knew human bones and muscles even better than did physicians. Some recognized that better anatomical knowledge plus more accurate and precise anatomical illustration would benefit would-be painters as well as students of medicine.

The 16th Century

Andreas Vesalius (1514-1564) from Brussels established the science of modern anatomy. Firsthand knowledge gained through dissection of the human body caused him to proclaim that the traditionally accepted anatomy of that time was not human anatomy. With publication of his *De Humani Corporis Fabrica* (1543) [5], Vesalius overthrew Galenic tradition. Despite his monumental contributions to anatomy, Vesalius gives depiction of the human kidney short shrift in some parts of his *Fabrica*. In book V, figure 22, the human kidney (fig. 2) is incorrectly shown higher on the right than the left. In the Galenic tradition, it had been theorized that a 'sieve arrangement' existed (fig. 3a) for straining urine in the kidney. Blood entered

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Fig. 3. Some illustrations of the kidney from Vesalius' *Fabrica*: the Galenic concept of the sieve arrangement (a) and Vesalius' dog kidney dissections (b) [reproduced from ref. 5, p. 515 and p. 371, respectively].

the upper portion of the kidney, was filtered by a sieve, and urine left by the ureter from the lower portion of the kidney (book V, chapter 10). Vesalius dissected a dog kidney (book V, fig. 21) and depicted his observations in three drawings (fig. 3b). His observations of the real kidney enabled him to refute the long-held sieve idea. Charles Estienne (1503-1564),

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Fig. 4. Woodcut illustration from Estienne's *De Dissectione* (p. 303). Note the inserted part of the woodblock (arrows) in this posed female figure [reproduced from ref. 6].

Fig. 5. Eustachio's depiction of a cut section of the kidney from his *Tabulae* (plate 5) reveals the renal pelvis and the calyceal system (top) as well as the arrangement of the renal vasculature and calyceal system (bottom). Note his use of coordinates framing the illustration [reproduced from ref. 12].

the son of a well-known French printing family, prepared what is regarded as the most fully illustrated 'state-of-the art' pre-Vesalian anatomical books. Published in 1545, it was entitled *De Dissectione Partium Corporis Humani* [6]. Estienne's *De Dissectione* is probably the most controversial anatomical atlas ever published. Among several various opinions, the Norman catalog describes it as 'one of the finest woodcut books of the French Renaissance' [7], whereas Charles Singer calls it the 'ugliest anatomical work we know' [8]. The illustrations of books two and three attracted attention, due to the obvious insertions of separately cut pieces in several woodblocks. This could suggest that the main blocks originally were intended for another purpose. In fact, a link has been established between Estienne's figures, some pictured in luscious poses, and a series of erotic prints entitled *Loves of the Gods* [7]. A drier explanation is that the reason for the insertions was to correct mistakes in his work, perhaps based on what he saw in Vesalius *Fabrica*, which was published a short while before Estienne completed his anatomy [9]. The illustration in figure 4 depicts the location of the right kidney incorrectly, higher than the left. The kidney size is inappropriately small in comparison to the exaggerated depiction of the internal genitalia in this female figure.

Bartolomeo Eustachio (1524-1574) was an anatomy professor at Collegia della Sapienza in Rome. He completed and personally had executed 47 drawings for copperplate engravings in 1552. These were intended to illustrate a book, *De Dissensionibus ac Contraversiis Anatomicis*. This book was never published. Twelve years after he completed the drawings, he used 7 of the 47 plates to illustrate his first anatomical work, *Opuscula Anatomica* (1564). This exquisite work had 147 pages devoted to the kidney. This was the first time copper was used for anatomical plates. Though Eustachio had described his observations of the kidney, the work was not circulated and this material, along with the remaining 40 unpublished plates, was inherited by a friend and fellow artist, Pier Matteo Pini, upon Eustachio's death. Eventually, these copper plates found their way to the papal library in Rome but remained in obscurity for 162 years. They were rediscovered only in the early 18th century [10], and were published in 1714 with marginal notes and a text edited by Giovanni Maria Lancisi [ref. 11, p. 221]. Lancisi extended to Eustachio full credit in the book entitled *Tabulae Anatomicae Bartholomaei Eustachi* [12]. Thus, Eustachio's genius became known to the world only 162 years after he had produced the copper plate illustrations.

Eustachio's contributions concerning the kidney are several: he was the first to describe the adrenal glands, he noted correctly that the right kidney is lower than the left, he clearly and accurately illustrated the intrarenal vasculature, he was the first to describe the renal calyceal system and its relation to the renal papillae, and his correct description of the renal collecting ducts ('certain furrows and small canals') [ref. 16, p. 19] antedated Bellini's observation by 150 years. Eustachio surmised that these tiny structures had a purpose in moving urine from the kidney to the renal pelvis. Figure 5, like all from the *Tabulae*, is framed with coordinates because Eustachio felt quite strongly about letters being placed on his artwork.

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Fig. 7. Ruysch's depictions of convoluted tubules on the surface of the kidney (left) and renal calyces and papillae in cut section (right) [reproduced from ref. 14].

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Fig. 6. Fetal skeletons, organ and tissue preparations of plate 1 of Ruysch's *Thesaurus Anatomicum* [reproduced from ref. 13].

Fig. 8. The ducts of Bellini in his *Exercitation* fig. 5 [reproduced from ref. 15].

The 17th Century

Frederik Ruysch (1638-1731) was a Dutch anatomist from Amsterdam. He was a pupil of Jan Swammerdam from whom he learned the technique of injecting wax into anatomic specimens. Ruysch improved upon his teacher's technique by using the microscope to control injections in very small structures. In addition, he injected dye substances into his specimens. Concerning his techniques he was said to be secretive. His innovations enabled him to perform detailed studies and to make observations that would not have been possible for his predecessors. His best known work, *Thesaurus Anatomicum* [13] contains his interesting, though sometimes bizarre, illustrations (fig. 6).

A plate from *Theatrum Anatomicum* [14] shows Ruysch's representation of the kidney (fig. 7). He was credited with the first illustration clearly demonstrating the major portion of the renal cortex to be composed of convoluted tubules. Ruysch was the first to recognize the capillary tuft of the kidney {*Thesaurus Anatomicum Decimus*. N. 85} He referred to them as 'glandulae.' Glomerulus Ruyschiana (renal glomerulus) bears his name.

Lorenzo Bellini (1643-1704) was an Italian anatomist and physiologist. At 19, he published his best known work, *Exercitatio Anatomica de Structura et Usu Renum* [15]. He showed the kidney was not a solid organ but that it was composed of ducts (fig. 8), which received the name ducts of Bellini. He truly believed his to be the first description of these structures. Ten years after Bellini's death, the long-lost observations of Eustachio were published by Lancisi (1714) and we now know that Eustachio, not Bellini, deserves credit for first describing the collecting tubules. Though Bellini did not give us a description of glomeruli in the kidney, he is recognized for suggesting that urine is separated from blood by a distinct anatomical arrangement [16].

Govard Bidloo (1649-1713), a Dutch anatomist from Amsterdam, prepared an atlas of anatomy with which he hoped he would be able to eclipse all prior atlases. This was to be based upon originality and merit of illustrations. The *Anatomia Humani Corporis* [17] contains excellent drawings which are considered among the finest illustrations of the Baroque period (fig. 9). In 1698, Bidloo's British contemporary, William Cowper (1666-1709), published another book, *The Anatomy of the Humane Bodies* [18]. Cowper's book was of the same proportions, contained the exact same 105 plates, in the exact same order as Bidloo's volume. The only different prints were the portraits of the authors. In Cowper's book, his portrait replaced that of Bidloo. The engraved title page (fig. 10) is the same in both editions except for the shield inscription. The text of this

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Fig. 9. Plate 42 of Bidloo's *Anatomia* depicting the kidneys and related structures [reproduced from ref. 17].

Fig. 10. Title page of Bidloo's *Anatomia* (left) and Cowper's *Anatomy* (right). The two illustrations are almost identical with the exception of the shield which bears the author's name and the title [reproduced from ref. 19, pp. 114, 119].

book, written in English, was actually considered a big improvement over Bidloo. Critics implied that Cowper's book supplied what Bidloo's had lacked and that his accurate, well-executed text provided fuller descriptions of the original plates. The book was widely used for the next 50 years. In 1700, Bidloo lashed out at Cowper in a scathing communication which he sent to the Royal Society, wherein he referred to Cowper as 'a literary highwayman' [19]. Prior to anything known as copyright laws, this was regarded as one of the most famous instances of plagiarism in the entire history of medicine.

As we noted earlier, the anatomic woodcut reached its peak in Vesalius' *Fabrica*. Anatomic illustrations from copper plate engravings, for which the 17th century was noted, depict the

accuracy, quality and degree of perfection that had been attained by the late 17th century [ref. 11, p. 250]. Figure 11 shows a kidney from Bidloo's book (bottom) and the same plate (top) from Cowper. Careful examination allows us to detect the minute differences in labeling the parts of the illustrations.

The 18th Century

Fig. 11. Identical copperplate illustrations of plate 43, figures 3-4 from Cowper's Anatomy (top) and Bidloo's Anatomia (bottom) representing cross-sections of the kidney. Subtle differences in labeling are identified (arrows) [reproduced from ref. 17 and 181].

Giovanni Battista Morgagni (1682-1771) came from Forlì, Italy. At the age of 79, he produced his masterpiece entitled *De Sedibus et Causis Morborum* [20] {The Seats and Causes of Diseases translated by Benjamin Alexander in 1769 [21]; fig. 12). Morgagni wrote the work based on case studies. It consists of

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Fig. 12. Title page of the 1769 English edition of Morgagni's *De sedibus* [reproduced from ref. 21].

Fig. 13. Plate XXII of Cheselden's *The Anatomy of the Human Body* [reproduced from ref. 22].

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THE

SEATS and CAUSES

OF

DISEASES

INVESTIGATED BY ANATOMY,

IN FIVE BOOKS,

CONTAINING

A Great Variety of DISSECTIONS, with Remarks.

TO WHICH ARE ADDED

Very Accurate and Copious INDEXES of the Figures and Names therein contained.

Translated from the Latin of

JOHN BAPTIST MORGAGNI,

Chief Professor of Anatomy, and Professor of the University of Pavia,

By BENJAMIN ALEXANDER, M. D.

IN THREE VOLUMES.

VOL. I.

LONDON,

Printed for A. Millar at J. T. Coddill, Successor, in the Strand

and J. Nodding and P. Neave, in Pall-mall.

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five books containing 70 letters which attempt to correlate signs and symptoms of disease with subsequent postmortem findings. His work represented the beginning of the science of pathology

and provided the first satisfactory rational and extensive determination of the anatomic location of disease. Unfortunately, Morgagni did not provide illustrations for his 2,242-page work, and this is truly a case where a picture would have been worth a thousand words.

In book III, Morgagni gave excellent descriptions of a number of renal disorders, some of which are listed in table 1. He used the term 'urine suppression' in some case discussions. In modern terminology we recognize that he was describing what is regarded as obstructive nephropathy. Some of the causes for obstructive uropathy which he noted are listed. In addition, his vivid description of anatomical material, correlated with clinical histories, allows us to offer plausible current-day identification for several renal abnormalities.

William Cheselden (1688-1752), an extremely talented English surgeon-anatomist who became known initially for having described his surgical procedure for lithotomy and later for ophthalmologic surgery, had been a pupil of Cowper. During the preanesthetic period in which he worked, he was regarded as having the most rapid operating time of all surgeons (54 s) for bladder stones [ref. 11, p. 343].

Cheselden went to London and in 1711 began teaching anatomy from his home, a practice which was against the rules of the Company of Barber-Surgeons. After he became associated

Table 1. Renal disorders mentioned by Giovanni Battista Morgagni in *De Sedibus et Causis Morborum* (1761) volume II, book III

Suppression of urine (obstructive nephropathy)

Calculi

Etiology?

Prostatic hypertrophy

Worms

Tumors Renal abnormalities

Renal agenesis with contralateral compensatory hypertrophy

Renal cysts

Duplicated collecting system

Vesicoureteral reflux

Urethral valves

Fetal lobulation of the kidney

Prune belly

as a surgeon with St. Thomas' Hospital, his problems with them ceased. Cheselden's *The Anatomy of the Human Body* [22] published in 1713 was a popular book that went through 14 printings in the 18th century. His atlas, *Osteographia, or the Anatomy of the Bones*, published in 1723 and illustrated by Van der Gucht is considered a classic. It is one of the first well-illustrated texts on comparative anatomy. His dissection (fig. 13) in the style of Vesalius, served as an example for several contemporary atlases.

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Conclusion

In summary, our presentation has bridged several centuries, showing examples from the most primitive depictions of the kidney (fig. 1) to the most sophisticated, artistically and anatomically perfect delineations (fig. 9). Each image reflected the medical knowledge of the age as well as some aspects of the

culture in general. Thus, through the examination of this lesser-appreciated organ, we can open views on art, history, sociology and different representations of human thinking. In other words, to quote from Homer W. Smith, again: ‘Superficially, it might be said that the function of the kidneys is to make urine, but in a more considered view one can say that the kidneys make the stuff of philosophy itself [23].

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