

Animals, Pictures, and Skeletons: Andreas Vesalius's Reinvention of the Public Anatomy Lesson

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ABSTRACT. In this paper, I examine the procedures used by Andreas Vesalius for conducting public dissections in the early sixteenth century. I point out that in order to overcome the limitations of public anatomical demonstration noted by his predecessors, Vesalius employed several innovative strategies, including the use of animals as dissection subjects, the preparation and display of articulated skeletons, and the use of printed and hand-drawn illustrations. I suggest that the examination of these three strategies for resolving the challenges of public anatomical demonstration helps us to reinterpret Vesalius's contributions to sixteenth-century anatomy. **KEYWORDS:** Andreas Vesalius; anatomy; dissection; skeleton; anatomical illustration; animals.

THE history of anatomy in the Renaissance has largely been the history of dissection. It is the process of physically examining bodies that drives the narrative of the changes in anatomy, especially in the sixteenth and seventeenth centuries.¹ Recent scholarship has made it clear that the occasions for human dissection can be separated into two broad categories—private dissections and public dissections at medical schools. Private dissections are known to have

1. Recent accounts of that history, for example, Roger French, *Dissection and Vivisection in the European Renaissance* (Burlington, Vermont: Ashgate, 1999) and Andrew Cunningham, *The Anatomical Renaissance. The Resurrection of the Anatomical Projects of the Ancients* (Brookfield, Vermont: Ashgate, 1997), are clearly built around the dissection questions.

been performed for a variety of scientific, religious, and legal reasons, but the nature and use of public anatomical demonstrations deserve further examination.²

The standard narrative of the history of anatomy holds that despite the advent of human dissection in the west by the fourteenth century, nothing new about the human body was discovered until the sixteenth century. It has been suggested that this was because prior to the sixteenth century, dissection was performed for purely educational reasons, and that the revolution in anatomical study (which is most closely associated with Andreas Vesalius) involved employing it for investigative purposes instead, a point bolstered by the observation that prior to the sixteenth century, public dissections were not actually performed by members of the medical faculty.³ Aside from the problem that arises from ignoring other possible forms of dissection, this position also presumes that the educational uses of public dissections can be understood as independent of their investigative value.

However, historians of medicine have recently begun to evaluate how educational approaches to medicine may inform us about medical practice and theory, demonstrating that examining what medical students and their teachers did in the course of instruction can shed light on how they practiced medicine and how they understood its theories.⁴ In the case of anatomy, the relationship between the public dissections of Fabricius ab Aquapendente in the late sixteenth and early seventeenth centuries and his work as both a teacher and an investigator has been especially revealing. Examination of Fabricius's writings has shown how his investigative program and his anatomical demonstrations intersected and how they conflicted with the expectations of his students. Despite these advances in understanding, however,

2. Public dissections are described in Giovanna Ferrari, "Public Anatomy Lessons and the Carnival: The Anatomy Theatre of Bologna," *Past Present*, 1987, 17, 50–106, and Cynthia Klestinec, "A History of Anatomy Theaters in Sixteenth-Century Padua," *J. Hist. Med. Allied Sci.*, 2004, 59, 375–412. For discussions of the other types of dissections, see in particular Katharine Park, "The Criminal and the Sainly Body: Autopsy and Dissection in Renaissance Italy," *Renaissance Quart.*, 1994, 47(1), 1–33, and Park, "The Life of the Corpse: Division and Dissection in Late Medieval Europe," *J. Hist. Med. Allied Sci.*, 1995, 50, 111–32.

3. This is the position taken by Andrea Carlino, *Books of the Body: Anatomical Ritual and Renaissance Learning*, trans. John Tedeschi and Anne Tedeschi (Chicago: University of Chicago Press, 1999), 2.

4. For medical practice and its links to teaching, see, for example, Michael Stolberg, "Bed-side Teaching and the Acquisition of Practical Skills in Mid-Sixteenth-Century Padua," *J. Hist. Med. Allied Sci.*, 2014, 69, 633–61.

the public dissection methods of Andreas Vesalius, a generation before Fabricius, are arguably among the most important of the sixteenth century and remain to be investigated.⁵

It is obvious that Vesalius too placed a good deal of emphasis on his public demonstrations, but beyond the old tale that he performed his own cutting while everyone around him preferred to delegate, there has been little exploration of how his methods compared to those of his predecessors or how the educational role of these demonstrations integrated with Vesalius's investigative concerns. In this paper, I offer some insight into the question by first identifying what appear to be specific changes in the nature of Vesalius's public dissection, by examining the reasons for those changes (which relate to their public nature), and finally by suggesting how these changes influenced Vesalius's anatomical investigations.

Prior to Vesalius, it was not unusual for anatomical authors to dismiss the viability of public demonstrations as a method of serious inquiry, not because the anatomist himself did no actual cutting (which was Vesalius's complaint), but because the procedure was severely constrained by practical limitations. Anatomists earlier in the sixteenth century preferred, therefore, to glean knowledge from other modes of dissection which overcame these practical limitations. Rather than questioning the utility of public dissection, Vesalius, by contrast, emphasized it as a model for how anatomy should be learned from the body itself. He was not ignorant of the limitations of the procedure, but he employed a number of innovative strategies to overcome them.

Vesalius's major modifications to the methods of public dissection included the use of animals as dissection subjects, the preparation and display of articulated skeletons, and the use of printed and hand-drawn illustrations. These three methods not only allowed him to pursue topics in public dissections that were generally considered to be impracticable by other anatomists, they also seem to have led him to some of his crucial insights into the human body itself. That, in turn, demonstrates that it is quite difficult to separate the educational purpose of public dissections from the investigative program of the anatomist, and further suggests that some influential anatomical observations expressed by

5. These aspects of Fabricius's work have been described by Cynthia Klestinec in *Theaters of Anatomy. Students, Teachers, and Traditions of Dissection in Renaissance Venice* (Baltimore: The Johns Hopkins University Press, 2011), 79–90.

Vesalius arose from his innovative attempts to demonstrate anatomy to others.

THE PROBLEM WITH PUBLIC DISSECTIONS

By 1500, public anatomical demonstrations had become a familiar event in medical schools across Europe, sanctioned by nearly two centuries of practice. There was a standard manual for the process, the *Anatomia mundini* (*Mondino's Anatomy*), which supplied both anatomical information and directions for making incisions. Statutes of various schools supplied details about the source of the bodies, the venue, dates, invited dignitaries, and paying audience, even what to do with the corpses once the dissection was complete. The details supplied in this documentation, but especially in Mondino's text, provide us with a fair understanding of what was going on during the dissection process itself.⁶

Mondino was clear that the primary focus was on the internal organs. These were easiest to see in a dissection. Other parts (such as muscles, for example) were only visible piecemeal as one went along and were better understood other ways, for example, by submerging a corpse in running water until the flesh was removed. It is quite likely that the book's structure drove what was discussed and dissected in other ways, since Mondino talked about certain aspects of the body in great detail and left others out completely. Mondino laid out a plan for public demonstrations to follow, and it is not unreasonable to think that they did.⁷

Early sixteenth-century anatomical books also provide us with some information about how these public dissections were understood to fit into the investigative program of anatomists. Best practices in the study of anatomy and the proper role of anatomical dissection were common themes in a diverse range of works, including books

6. Details of the public anatomy demonstration are discussed in numerous sources. See, for example, Jerome Bylebyl, "Interpreting the Fasciculo Anatomy Scene," *J. Hist. Med. Allied Sci.*, 1990, 45, 308–16. M. G. Nardi, "Statuti e documenti riflettenti la dissezione anatomica umana e la nomina di alcuni lettori di medicina nell'antico stadium generale fiorentino," *Riv. Stor. Sci. Mediche Nat.*, 1956, XLVII, 237–49. Carlino, *Books of the Body*, 77–119 and Cynthia Klestinec, "Civility, Comportment, and the Anatomy Theater: Girolamo Fabrici and His Medical Students in Renaissance Padua," *Renaissance Quart.*, 2007, 60, 443–44.

7. Mondino dei Liucci, *Anatomia Mundini, ad vetustissimorum erudemque aliquot manu scriptorum codicum fidem collata, iustoque suo ordini restitute per Joannem Dryandrum* (Marburg, 1541), 2r. On Mondino's influence on the parts of the body studied in the sixteenth century, see Cunningham, *The Anatomical Renaissance*, Chapter 1.

by Gabrielle Zerbi (1502), Berengario da Carpi (1521), and Niccolò Massa (1536), all of whom explicitly linked their text to Mondino's.⁸

These anatomists and other authors of the early sixteenth century routinely expressed doubt about the utility of public dissections for investigation. The most obvious problem concerned the supply of cadavers. Bodies for public demonstrations were supplied by local authorities from the ranks of executed criminals, and although the statutes of medical schools called for two bodies—generally one male and one female—in practice there was often only a single corpse. A lack of supply represented a real practical issue because cutting up a body to see one of its structures invariably destroyed other parts, rendering them unfit for further examination. This meant that one could not thoroughly examine every part of the body in a public demonstration limited to one corpse, and even two bodies might not be sufficient.

The supply problem is clearly documented in anatomical texts written in the early sixteenth century, including books by Zerbi and Berengario written about twenty years apart. The two works are not unrelated, and Berengario was clearly influenced by Zerbi in a variety of ways. Although it is Berengario whom historians typically associate with dissection, both authors provided extensive and nearly identical advice about the dissection process, including pointing out the problem with public dissections. Zerbi addressed the issue at the beginning of his text in the section where he offered advice about the proper methods for anatomical study. He embraced the study of anatomy from dissection, but he also noted that a single body was not adequate for proper understanding. Multiple bodies were especially necessary, according to Zerbi, because one part was often destroyed in the process of examining another, as was the case with the ventricles of the brain.⁹

Twenty years later, Berengario repeated this warning about destroying one part while examining another, once again citing the brain as an example. But Berengario also elaborated on the problem later in the text where he noted it was necessary to dissect more than one brain to obtain a clear understanding of its internal structure, and

8. Berengario da Carpi, *Commentaria cum amplissimis additionibus super anatomia Mundini una cum textu eiusdem in pristinum et verum nitorem redacto* (Bologna, 1521) and Berengario da Carpi, *Isagogae breves et exactissimae in anatomia humani corporis* (Bologna, 1522). Gabriele Zerbi, *Liber anathomie corporis humani* (Venice, 1502). Niccolò Massa, *Liber introductorius anathomiae* (Venice, 1536).

9. Zerbi, *Anatomie*, 2v–3r.

thus the kind of dissection performed in front of a crowd, as was the case in the “anatomy of the schools” (*anatomias scolaribus*), was not adequate. Here, Berengario made it clear that the issue was that public demonstrations involved only one body and were therefore not definitive investigations.¹⁰

Berengario repeated his condemnation of the public dissections of the schools in more than one context. In addition to the brain, he noted that some parts of a body must be destroyed or removed in order to see other parts properly when examining the mesentery. Because of this, multiple dissections must be made in order to acquire knowledge of the kind that was not normally obtainable in a public dissection (*anatomia communi*). Again, the connection between the limitations imposed by dissecting one body and the public demonstration is clear.¹¹

Similar remarks about the limitations of a single cadaver and of the public dissection process in general were made by other authors. Niccolò Massa clearly noted that what could be easily seen in a single body was not everything that could be known about anatomy and claimed that he had written his book on anatomy with that idea in mind. His goal was to guide the reader through a single-body dissection which left his discussion incomplete. He was especially concerned that by the time a reader reached the passages on the bones and muscles, which appeared at the end of his book, those parts would be thoroughly mangled from previous procedures and no longer suitable for study. To make up for this deficiency, Massa promised (but never delivered) to write a more definitive account of anatomy in another book.¹²

When discussing the recursive (laryngeal) nerves, Massa noted another problem with public demonstrations. The details of the complex path followed by those nerves were not “revealed in dissections which are conducted to teach the young” because of time constraints. Massa noted that while a single body was adequate for the task, proper study required the dissector to examine a body for as long as necessary

10. Berengario, *Commentaria*, 438r. For the connections between Berengario and Zerbi, see French, *Dissection and Vivisection*, 91–95.

11. Berengario, *Commentaria*, 119v and 479v. Katharine Park has also noted these objections by Berengario in *Secrets of Women, Gender, Generation, and the Origins of Human Dissection* (New York: Zone Books, 2006), 168.

12. Massa, *Anathomiae*, 100v–101r.

to understand the details, something not feasible during the limited timeframe of public demonstrations.¹³

Jean Fernel also expressed reservations about single-body dissections. Near the end of the first book of his *Physiologia*, Fernel suggested that the best way to follow his discussion of anatomy was to dissect one cadaver for the muscles and bones, a second one for the viscera, a third for veins, a fourth for the arteries, and a fifth for the nerves. Fernel understood, however, that this approach was not likely to occur. Public dissections required that everything be shown in a single body, and Fernel explicitly linked his discussion to that scenario.¹⁴

Fernel and Massa highlighted the limitations on the parts of the body that could be easily examined. As Mondino had noted, the internal organs were suitable for study by dissection, but things like bones or muscles or nerves as they were arrayed throughout the body were not. Typically, one needed a different approach, one that was assumed to occur outside the public demonstration. Common suggestions for examining the bones, for example, included removing the flesh by boiling, submerging a corpse in a stream of water, stealing bones from graveyards, or taking advantage of their visibility in the severely emaciated.

Berengario understood the issue as well, and he made it clear, for example, that it was not possible to see the muscles or the bones of the *whole* body in the kind of dissections normally held in the schools because of the extreme labor and long time required to uncover them (presumably by boiling or something similar). In another passage, he repeated the point, again saying it was not possible to see “the number of muscles, nor bones, nor nerves nor veins” in the kind of public dissections found in schools.¹⁵

An additional issue arose from the *types* of bodies dissected. Berengario and Zerbi were both strong advocates for experience with a wide variety of body types, old and young, male and female, animal and human. But they provided these lists when describing the qualities of an accomplished anatomist and the sorts of experiences he

13. Massa, *Anathomiae*, 61r.

14. Jean Fernel, *Universa medicina, tribus et viginti libris absoluta* (Paris, 1567), 161. Fernel's anatomical material was also printed earlier in Jean Fernel, *De naturali parte medicinae libri septem* (Paris, 1542).

15. Berengario, *Commentaria*, 479r.

should have. When it came to describing the kinds of bodies used in public dissections, they were much more constrained. Berengario, for example, noted that for a dissection like the one described by Mondino the ideal body was neither too young, nor too old; neither too thin, nor too fat. Similar descriptions about the types of bodies used in public demonstrations can be found in other anatomical texts. Alessandro Benedetti, for example, offered nearly the same advice as Berengario by describing the ideal body for a public dissection as middle-aged, neither thin nor obese, and tall so that the spectators in the audience would have a chance to see.¹⁶ The requirements that Berengario and Benedetti listed were repeated by others and linked by them to public dissections where both a certain standardization and easy visibility were desirable.

Perhaps the clearest description of the differences between the kind of bodies used in public demonstration and the kind dissected privately came from Vesalius himself. In the fourth book of the *Fabrica* under the chapter entitled “How to Undertake a Dissection,” Vesalius famously noted that the best cadaver to use in public dissections was an “average specimen,” in middle age, one that formed a standard like Polycletus’s statue. Private dissections were different. In those, any sort of body was acceptable, according to Vesalius, and even useful for noting the differences between bodies and the true nature of diseases. Tellingly, Vesalius noted that when he did encounter something anomalous in a public demonstration, he passed over it in silence so as not to confuse his audience.¹⁷

We have seen a laundry list of problems associated with public dissections in medical schools supplied by early sixteenth-century anatomists, and with it a distinct belief that there were differences between public demonstrations with their largely educational mission, and other dissection activities that, by being more comprehensive, led to more extensive anatomical knowledge. According to authors like Berengario and Zerbi, a good anatomist performed all kinds of examinations on all kinds of bodies, both animal and human, sick and well, and in the

16. Alessandro Benedetti, *Anatomice sive historia corporis humani* (Paris, 1514), 7.

17. Andreas Vesalius, *De humani corporis fabrica libri septem* (Basel, 1543), 548. As Nancy Siraisi notes (in “Vesalius and Human Diversity in *De humani corporis fabrica*,” *J. Warburg Courtauld Inst.*, 1994, 57, 61), Vesalius changed this advice in the second edition of the *Fabrica* where he suggested that even nonstandard bodies might be useful for public demonstrations as a means of teaching about variation.

context of medical practice as well as medical education, the public demonstration being only one, limited example. On the other hand, the general message from Andreas Vesalius in his *Fabrica* described a completely different scenario.

In his dedication to the *Fabrica*, Vesalius objected to the public dissections held in medical schools not on the grounds that they were unsuitable for serious investigation, but because the faculty in charge of them did not perform the work themselves. He used this objection as a means of highlighting his own superior knowledge of anatomy, which was acquired beginning at an early stage in his medical learning. He supplanted the barber, or surgeon normally assigned the job of cutting open the corpse in public demonstrations and performed the dissection himself.¹⁸

Historians often accept Vesalius's claims at face value, building elaborate narratives about a changing dissection procedure where the anatomist assumes the role of the dissector in the course of the sixteenth century. But, there is certainly an element of spin in Vesalius's description, which is not a complete and accurate portrayal of contemporary dissection practices for the simple reason that, as we have seen, it was dissection outside of the public demonstration that counted most in the minds of many authors. Why would Vesalius adopt this approach?¹⁹

Part of Vesalius's story lies in Paris where the situation was much as he described it and where some of his teachers were launching a campaign to change things. Yet, another important aspect is rooted in Padua where Vesalius had been teaching as he developed and published the *Fabrica*. Another famous member of the faculty at Padua at the time, Giovanni Battista da Monte, also seemed to be very interested in the teaching aspects of his profession. It is well known that da Monte took his students on rounds with him, and recently, it has been shown just how much effort he made to ensure students put their own hands on patients, taking pulses, checking urine, and conducting interviews. The kind of teaching that we would describe today as "hands on" seemed prized in the medical school of Padua in the sixteenth century, and it is certainly true that in the decades after Vesalius, anatomy faculty

18. See R. Allen Shotwell, "The Revival of Vivisection in the Sixteenth Century," *J. Hist. Biol.*, 2013, 46, 171–97.

19. See, for example, Carlino, *Books of the Body*, chapter 1 which traces the iconography of the public dissection and the shifting roles of the participants.

who neglected this sort of approach were apt to be the subject of student complaints. If Vesalius therefore championed hands-on dissection in an educational setting, he was fitting himself into a general approach to medical education in Padua at the time.²⁰

It was not enough to champion public demonstrations however. To be truly effective, Vesalius needed to find ways to conduct demonstrations that would overcome the limitations involved. How could he solve the problem of a limited supply of cadavers, issues with what could be seen by dissection, and similar matters? It appears that there were three main ways—by using both animal and human subjects, by displaying an articulated skeleton, and by making use of printed and hand-drawn illustrations.

ANIMALS AND COMPARATIVE ANATOMY

Often the history of dissection in the early sixteenth century is seen as a contrast between animal dissection and human dissection, especially in the case of Vesalius. It was Vesalius who made the startling announcement that Galen had mistaken animal for human anatomy and was therefore wrong on a number of points. The truth is that animal and human dissections were often performed interchangeably, even by Vesalius himself. Animals filled an important role as substitutes for human corpses.

There were a variety of reasons why animal dissection might be employed. Human bodies might not be available, or humans might not be suitable for certain procedures, or the anatomical part being examined might be harder to understand in humans because it was smaller, or filled with fatty tissue, or some other practical reason. The first problem, the lack of a human specimen, often occurred when a dissection was part of a private lesson such as those taught by a physician in his home, and in cities that did not have a major medical school. In these cases, there might not be ready access to human cadavers like those supplied by the authorities to medical schools. In such a case, dissections were done on animals instead. This seemed to be the case in 1519, for example, when Ippolito of Montereale, who was living with

20. For da Monte's approach to patients, see Jerome Bylebyl, "The Manifest and the Hidden in the Renaissance Clinic," in *Medicine and the Five Senses*, ed. W. F. Bynum and Roy Porter (Cambridge: Cambridge University Press, 2005), 40–60. For his work with students and its manual aspects, see Stolberg, "Bedside." For student reactions to changes in practical approaches to methods of anatomical instructions, see Klestinec, *Theaters*, 79.

the physician Giovanni Lorenzo in Perugia and studying medicine with him, recorded a description of the dissection performed on a pig. Lorenzo and Ippolito began by removing the skin and opening the body of the pig “so that we might see the interior and the origin of the nerves,” but they skipped some parts because they did not resemble the human body which was the real subject of their study.²¹

Conducted at Lorenzo’s home, Ippolito’s dissection of a pig was an exercise outside of the public anatomy lesson with its officially sanctioned supply of human cadavers and in this respect must have been similar to an account given by Berengario da Carpi in the dedication to his *Isagogae Breves* (the epitomized form of his commentary) of 1522. Recalling how he and his dedicatee, Alberto Pio, were tutored together in their youth by Aldus Manutius, Berengario wrote

I am certain that you cannot have forgotten the many honorable studies we shared as we learned the rudiments of the gentler Muses under our Roman teacher, Aldus Manutius, of happy memory. First of all, I doubt that your lofty and god-like mind has forgotten what youths always enjoy, learning something as a sport. We both enjoyed it when we had to dissect a pig. The task fell to me, since I had practiced the surgeon’s art under my father’s direction ever since childhood. From that time onward I was so fond of anatomy that I spent all my time at it.²²

Berengario and Pio were not attending a medical school, but being privately taught, and like Ippolito, this probably made it difficult for them to dissect human bodies to learn anatomy. The pig was a useful substitute because, as Ippolito noted, at least some of its parts resembled human anatomy. Something similar was probably behind the reported tendency of Jacobus Sylvius in Paris in the 1530s to bring rotting bits of animal carcasses to class, since he considered examining actual bodies as important for providing firsthand experience, but in all likelihood would have lacked the ability to bring parts of a human cadaver to class.²³

21. Dorothy Schullian, “An Anatomical Demonstration by Giovanni Lorenzo of Sassoferato, 19 November 1519,” in *Miscellanea di scritti di bibliografia ed erudizione in memoria di Luigi Ferrari* (Florence: Olschki, 1952), 487–94. Katharine Park has also discussed Ippolito’s experience in *Secrets*, 168.

22. Translation given in Jacopo Berengario, *A Short Introduction to Anatomy*, trans. L. R. Lind. (Chicago: University of Chicago Press, 1959), 35.

23. For Sylvius, see C. E. Kellet, “Sylvius and the Reform of Anatomy,” *Med. Hist.*, 1961, 5, 104.

Later in life, Berengario dissected animals again when he turned to investigating the anatomy of the fetus. This time the problem was the lack of the right kind of human body. Berengario complained that his access to human fetuses was severely hampered by the prejudices of midwives he had tried to bribe to obtain stillborn infants. To thoroughly investigate fetal urination, therefore, he was forced to turn to dogs. In the same way that the pig served as a substitute for a human when Berengario was young and human subjects were scarce, the dog served as a substitute for human fetuses, when as a practicing surgeon and a professor at Bologna, he had access to other types of human bodies but rarely fetuses.²⁴

There were other reasons to use animals. Vivisection was the most prominent one, although public vivisections in the sixteenth century seemed to have originated with Vesalius.²⁵ Later in the sixteenth century, Fabricius da Aquapendente would make extensive and deliberate use of animal dissection in his public demonstrations in an effort to expand the range of anatomical study, and Felix Platter described the dissection of a monkey by Guillaume Rondelet for the benefit of medical students at Montpellier in the years just after the appearance of the *Fabrica*. Platter also noted that he never neglected the dissection of “men and animals” when he was at Montpellier, implying they were both involved in his medical studies.²⁶

But Platter’s experience at Montpellier and Fabricius’s dissection of animals at Padua differed from the accounts of Berengario and Ippolito earlier in the century because they were clearly linked to public dissections conducted at medical schools, and it seems that the second half of the sixteenth century saw an increase in animal dissections in that particular setting. The evidence suggests that Vesalius himself influenced that practice. As Nancy Siraisi has noted, another anatomist of the later sixteenth century, Girolamo Cardano, certainly gained his interest in dissection from Vesalius and associated his careful consideration of how animals should or should not be used in studying human anatomy with

24. Berengario, *Commentaria*, 259v–260r.

25. Shotwell, “Vivisection,” 183.

26. For Fabricius’s use of animals, see Andrew Cunningham, “Fabricius and the ‘Aristotle Project’ in Anatomical Teaching and Research at Padua,” in *The Medical Renaissance of the Sixteenth Century*, ed. Andrew Wear, R. K. French, and I. M. Lonie (New York: Cambridge University Press, 1985), 223–45. For Platter, see Sean Jennet, *Beloved Son Felix: The Journal of Felix Platter a Medical Student in Montpellier in the Sixteenth Century* (London: Frederick Muller, 1962), 88.

Vesalius's work. Obviously, this is partly true because Vesalius had demonstrated the dangers of confusing animal and human anatomy, but there are other examples of the effect Vesalius had on animal use, including Realdo Colombo who vivisected dogs in what seems a close emulation of Vesalius.²⁷

It is certainly true that Vesalius employed animals in his public dissection. The account of a dissection he performed at Bologna in 1540 is filled with references to them and provides details that give us a good idea about the reason for their extensive use. Another account—that of a dissection he conducted at Padua in 1537—also refers to his use of a dog. At the end of his written account of the dissection at Bologna, the student whose notes survive, Baldasar Heseler, summarized the proceedings by noting that he had just described the dissection of “three humans and six dogs,” a two-to-one ratio of animals and humans. Heseler's count was actually a bit low, since Vesalius also dissected other animals, or parts of animals, besides dogs.²⁸

One reason that Vesalius needed all of those animal bodies at Bologna was to solve the problem that anatomists from Zerbi to Massa had already noted, the limitation involved in destroying one part while dissecting another. Early in the proceedings, for example, he announced, that he would use a dog to demonstrate the liver and the veins because he wanted to avoid damaging the heart in the human cadaver.²⁹

Vesalius repeated the idea that animal bodies could serve this particular purpose in Book V of the *Fabrica* in a passage glossed as, “How the course should begin when all the parts have to be demonstrated using a single cadaver.” There Vesalius described in detail what a dissector should do when he only had one body, the context making it clear that Vesalius means at a public demonstration. His two practical suggestions were to have a skeleton handy and to dissect animals along with the human cadaver in order to show some of the parts of the body, since “there is no need to damage the human cadaver to this

27. Nancy Siraisi, *The Clock and the Mirror. Girolamo Cardano and Renaissance Medicine* (Princeton: Princeton University Press, 1997), 93–118.

28. The Bologna account is by Baldasar Heseler, *Andreas Vesalius' First Public Anatomy at Bologna 1540: An Eyewitness Report by Baldasar Heseler*, trans. and ed. Ruben Eriksson (Uppsala and Stockholm: Almqvist and Wiksells, 1959). The quotation is on page 293. The Padua notes are MS. 11,195, Austrian National Library, Vienna, and were reproduced in M. Roth, *Andreas Vesalius Bruxellensis* (Berlin: G. Reimer, 1892), 454–57.

29. Heseler, *Vesalius*, 159.

end.”³⁰ We shall turn to the skeleton in the next section, but for now Vesalius’s statement makes it clear that one purpose for animal dissection was to accommodate the lack of subjects typical of public demonstrations.

At Bologna, the supply of animals actually allowed Vesalius to overcome the limitations of a single human corpse in other ways as well. One striking feature of the dissection at Bologna is the amount of time Vesalius spent discussing the muscles, often at the expense of the internal organs. He actually began his first demonstration, conducted after Matteo Corti had lectured on the intestines and mesentery for two days, by describing the muscles in great detail and producing a dog in order to show how its muscles differed from humans. Two days later, by the time Vesalius got around to the intestines, the human body had reached such a state of decay that dissecting its intestines was not possible. Undeterred, Vesalius produced another dog and used it to demonstrate the intestines instead.³¹

Vesalius had a strong interest in the muscles, and he studied and wrote about them far more extensively than any of his sixteenth-century predecessors and possibly more than any of his contemporaries. In the dissection at Bologna, Vesalius’s focus on the muscles was so extreme that by the third demonstration, many of the physicians in the audience left because the topic was of more concern to surgeons than to them, and by the fifth demonstration, Heseler was accusing Vesalius of neglecting other anatomical topics because of his obsession with the muscles.³²

But animals helped Vesalius demonstrate other parts of the body as well. Vesalius used the head of an ox to show the larynx, for example, because the human cadaver he had been provided with had been hanged and its neck crushed. When he turned to dissecting the brain, he substituted a sheep’s head because, he noted, it was easier to see the structures in it. Vesalius also needed a pregnant dog to show the uterus and the fetus since his human subject was male, and he needed a living dog for vivisection.³³

For Vesalius, therefore, animal bodies were useful for solving issues related to supply and for expanding his dissections to include a wide

30. Andreas Vesalius, *De humani corporis fabrica libri septem* (Basel, 1543), 548.

31. Heseler, *Vesalius*, 107.

32. *Ibid.*, 109 and 127.

33. *Ibid.*, 209, 285, 291

range of anatomical facts, both factors involved in his championing of public demonstrations. There were other issues to overcome, however. Most importantly, there was the basic problem identified by Mondino and reinforced in the sixteenth century that dissection was really only suitable for studying the internal organs. It offered little insight into the bones, veins, nerves, muscles, or arteries especially in terms of how they were arranged and distributed throughout the body. For that kind of knowledge, other approaches were necessary.

SKELETONS

While Mondino's suggestion that a whole body might be submerged in water to allow the flesh to be stripped away, leaving behind the bones, muscles, and similar parts was often repeated in the sixteenth century, it seems that the procedure was generally considered less efficient than other methods. To study the bones, in particular, anatomists could scavenge them from graveyards or dismember a corpse and boil away the flesh. As we shall see, however, there was a sharp distinction between methods that allowed the bones to be seen only in isolation (like getting them from the graveyard) and those that allowed them to be seen as a complete whole as they were arranged in the body itself.

Alessandro Benedetti provided an extensive discussion of preparing bones for examination in his book written in the late fifteenth century. Peppering his descriptions with gruesome and entertaining anecdotes like that of the physician who plucked a piece of human flesh from the pot in which the bones were being prepared and popped it into his mouth, Benedetti described boiling a dismembered body as the preferred method for preparing the bones for study, and in this, he was in keeping with other anatomists in the early sixteenth century, although there were alternative methods.³⁴

In his own discussion of the simple parts at the end of his work, Zerbi referred to Aristotle's *Parts of Animals* as his source for remarks about technique. According to Zerbi, Aristotle mentioned that the simple members were rendered more visible in bodies that had undergone severe emaciation, but Zerbi thought this approach was inadequate and recommended digging up bodies that had been buried for a long time instead.³⁵ Obtaining bones from graves or even from unburied corpses

34. Benedetti, *Anatomice*, 6or.

35. Zerbi, *Anatomie*, 3r.

seemed to be a common practice in the sixteenth century, and Vesalius was involved in obtaining the skeleton of a hanged highwayman who had been left swinging on the gibbet, secreting the parts along the side of the road and sneaking out of the city at night to recover them.³⁶ But when it came to formally discussing the preparation of the simple parts in the chapter of the *Fabrica* devoted to the subject, Vesalius described both boiling and submersion and expressed a preference for the former.³⁷

Dismissing Mondino's suggestion of immersing a body in a stream of water as crude and ineffectual, Vesalius provided a detailed account of boiling the flesh from the bones. First, the flesh of each part of the body was stripped and each bone separated. The bones were then boiled in a large cauldron and the flesh and fat skimmed off. Individual bones were picked out of the pot and scraped of their remaining flesh with a knife. The bones of the hand and forearm were dried slowly near a fire to preserve the ligaments. Finally, Vesalius emphasized assembling a skeleton from the bones after they had been prepared in order to see them all in their proper place.³⁸

Like his use of animals for dissection, Vesalius's attention to assembling skeletons seemed to be a product of the type of public demonstrations he liked to perform. While earlier anatomists, like Zerbi, Berengario, and Massa, had formally separated the study of the bones from the process of dissection and sometimes went so far as to use the lack of opportunity to study them as a criticism of public demonstrations, none of them mentioned Vesalius's idea of preparing an articulated skeleton.

Vesalius himself seemed to think the articulated skeleton was largely his own invention. He claimed that it was because of him such skeletons could be found in a number of medical schools in Europe, and we certainly know that he personally prepared some to give to

36. See C. D. O'Malley, *Andreas Vesalius of Brussels. 1514–1564* (Los Angeles: University of California Press, 1964), 137–38. Later in the sixteenth century at least, it seems that medical students were or were at least perceived to be the perpetrators of clandestine acquisition of bodies and skeletons. See Klestinec, *Theaters*, 134.

37. For a description of Vesalius's work with skeletons, see Sachiko Kusakawa, "Vesalius, the Book and the Bones," in *The Alchemy of Medicine and Print: The Edward Worth Library*, Dublin, ed. Danielle Westerhoff (Dublin: Four Courts Press, 2010), and M. Kornell, "Vesalius' Method of Articulating the Skeleton and a Drawing in the Collection of the Wellcome Library," *Med. Hist.*, 2000, 44, 97–110.

38. Vesalius, *Fabrica*, Book I, Chapter 39.

other physicians. On the other hand, we find a similar description of preparing skeletons in the work of Vesalius's contemporary and fellow student at Paris, Charles Estienne, and a few years later, Felix Platter would also mention producing a skeleton.³⁹ These sources are closely connected to Vesalius and might well have been inspired by him, although I have not investigated that possibility to any great extent. It is also true that images of skeletons appeared in a number of early printed medical texts and broadsides, although there again the images do not seem to suggest they represented articulated examples, and the veracity of Vesalius's claims still awaits an investigation.

Whether it was his invention or not, as we have already seen Vesalius did say in the *Fabrica* that an articulated skeleton (along with animal specimens) was a good way to conduct a public demonstration when the supply of bodies was limited. The record of his dissection at Bologna indicates that Vesalius certainly used his articulated skeleton extensively, starting on the first day. Its basic purpose was to allow Vesalius to show his audience exactly where parts of the body were located and how they interconnected, and it served as more than just a method of seeing the bones. Most notably, Vesalius used the skeleton in his discussion of the muscles.

The ninth demonstration by Vesalius at Bologna is one example of a repeated pattern of skeleton use. Here, Heseler described how Vesalius demonstrated the muscles of the hip, "one of which he showed us stretching from the ileum along the hip unto the leg, and this muscle, he said, is the longest in the whole body." Vesalius showed this muscle on the skeleton "where he first, as he usually did, explained and showed us the bones to which the muscles are fixed."⁴⁰

The skeleton was useful, therefore, not only for showing the bones, but also for the muscles. In both cases, the skeleton let the audience to visualize the arrangement in the body. The ways the muscles connected to the bones and how they were arranged in various places beneath the skin and fat that normally covered them were important to Vesalius. We are often reminded of that importance by the striking illustrations of the muscles found in the *Fabrica*, and these kinds of illustrations represented another aspect of the way Vesalius performed

39. Charles Estienne, *De dissectione partium corporis humani libri tres* (Paris, 1543), 374–75.

40. Heseler, *Vesalius*, 165.

public demonstrations. By using illustrations, Vesalius could show his audience things that were hard to see in the body itself.

ILLUSTRATIONS

To overcome the issue of supply and especially to provide an audience with the means of seeing parts of the body not readily revealed by dissection, Vesalius often employed illustrations. By illustrations, I mean both the drawings made by Vesalius during the course of the dissection and printed illustrations, both his own and those of his contemporaries. Illustrations played many roles in Vesalius's work, but the origin of his printed images of the body is famously linked to his teaching efforts at Padua. In his early, illustrated anatomical work, the *Six Anatomical Tables*, Vesalius identified a drawing of the veins made while teaching at Padua as his inspiration for producing the book. Vesalius claimed that those who saw his diagram begged him to produce additional ones showing the arteries and the nerves. All such diagrams, Vesalius noted, were especially useful in conducting public demonstrations.⁴¹

As Sachiko Kusakawa has recently pointed out the “treatment of inflammation” that prompted the diagram of the veins Vesalius described in the *Tabula* was linked to an ongoing controversy about bloodletting that ultimately involved most physicians in the early sixteenth century. Vesalius's work on this subject was an important aspect of both his printed works and his public demonstrations and was intimately connected to his illustrations. Vesalius's interpretation of the proper method of bloodletting involved specific facts about the location and arrangement of the veins, facts sometimes difficult to see in the body itself. For example, the location of the pain experienced by the patient and the proper spot from which blood must be drawn were to be understood in terms of the distance and the paths between the two points and therefore relied heavily on where the veins were located both with respect to each other and with respect to other parts of the body like the heart. The entire argument was fairly complex, and in public dissections, Vesalius found it easier to

41. See Charles Singer and C. Rabin, *A Prelude to Modern Science: Being a Discussion of the History, Source and Circumstances of the “Tabulae Anatomicae Sex” of Vesalius* (Cambridge: Cambridge University Press, 1946), iv.

reinforce his ideas with the audience by using an illustration rather than a body.⁴²

When he discussed the topic at Bologna, for example, Vesalius showed the audience a diagram of the veins from his book on venesection which he had published in 1539. This illustration simplified the layout of the veins, highlighting the key features involved in bloodletting. As described in this text and the notes from Bologna, much of the important information involved the position of azygos vein with respect to the heart and the distance between different locations. Features like these were well known to be hard to see in a dissection both because of the difficulty in locating the veins and because of the variation in bodies.⁴³

Vesalius also made use of other printed illustrations at Bologna, one of them from another person's book. When discussing the human brain, Vesalius showed his audience the illustrations found in a book by Johannes Dryander. Dryander's book depicted the dissection of the human head in a step-by-step series of figures that eventually led to the internal structures of the brain itself. Historians have noted the close connection between those illustrations and the ones found in the *Fabrica*, and it seems that on some level, Dryander's image must have reflected what Vesalius understood to be the proper structures of the head and brain.⁴⁴

The ventricles of the brain were also the structures described by both Zerbi and Berengario as not readily studied in public dissections, the problem being the destruction of one part in the uncovering another. It is perhaps significant Berengario printed an image of the brain as well. There was certainly a proliferation of brain illustrations in the early sixteenth century which went beyond the three examples I have mentioned here (Berengario, Dryander, and Vesalius) and seems to indicate that the subject was widely considered both important and well suited for illustrations.⁴⁵

42. Sachiko Kusakawa, *Picturing the Book of Nature: Image, Text, and Argument in Sixteenth-century Human Anatomy and Medical Botany* (Chicago: The University of Chicago Press, 2012), 184–90.

43. See, for example, Benedetti, *Anatomice*, 53v–54v.

44. Charles Singer, "Brain Dissection before Vesalius," *J. Hist. Med. Allied Sci.*, 1956, 11, 261–74, and Charles Singer, *Vesalius on the Human Brain* (New York: Oxford University Press, 1952).

45. Another example of illustrated, dissected brains appears in Hans von Gersdorff's *Feldtbuch der Wundtartzney* (Strasbourg, 1517).

Printed illustrations were not the only kind used by Vesalius in Bologna. At one point, he used a bit of charcoal to sketch the shape of certain muscles associated with the shoulder blade on the surface of the dissection table (Heseler, dutifully copied this sketch into his notes). Vesalius actually made a number of sketches during the dissection, although Heseler only identified two of the five sketches found in his notes as reproductions of what Vesalius had sketched. According to Heseler, the muscles Vesalius demonstrated (both in the cadaver and by drawing them with charcoal) would normally have to be looked up in books that both described and depicted them, a striking sentiment at a time when the number of books that actually have such illustrations was quite small.⁴⁶

There is a second extant copy of notes from a dissection performed by Vesalius that reinforces the role of illustrations. In 1537, Vesalius conducted a dissection at Padua, which was recorded by Vitus Tritonius Athesinus. As was the case in the notes from Bologna, Vitus included five drawings and noted Vesalius's uses of illustrations. Vesalius's *Tabula* was not yet in print, but Vitus noted that Vesalius showed his audience illustrations which would soon appear in published form. Vitus's own sketches, like Heseler's, included images of the nerves and of the veins.⁴⁷

Many of the subjects of these illustrations, like the muscles mentioned by Vesalius, were hard to see in the body itself for different reasons. In the *Fabrica*, Vesalius would offer specific advice about how to best go about seeing certain muscles in the body including dissecting animal specimens first because the presence of the muscle in animals made it easier to notice their absence in humans. "It should come as no surprise that when I am demonstrating human anatomy in a public dissection I always have an ape or a dog at hand," Vesalius exclaimed in the same passage.⁴⁸

46. Heseler, *Vesalius*, 139. I wish to thank the anonymous reviewer of this essay for drawing my attention to this fact and to the note to the same effect in Heseler, *Vesalius*, 315, n.15.

47. For an account of these notes, see C. D. O'Malley, "The Anatomical Sketches of Vitus Tritonius Athesinus and Their Relationship to Vesalius' *Tabulae anatomicae*," *J. Hist. Med. Allied Sci.*, 1958, 13, 395–97.

48. Vesalius, *Fabrica*, 288.

CONCLUSIONS

We have seen that a fairly widespread discussion of the limitations of public dissections as a method of anatomical investigation in the early sixteenth century gave way, at least in the case of Vesalius, to an emphasis on that procedure as a paradigm of the dissection experience. While figures like Berengario, Zerbi, and Massa suggested that the limitations of dissecting a single corpse affected the usefulness of public dissection, Vesalius disparaged the process because the professor in charge did not do his own cutting, and promoted himself as superior because he had changed that practice. While embracing the public demonstration in this way, Vesalius also addressed the concerns of earlier anatomists by employing a number of methods, most notably using animal bodies as well as humans, preparing articulated skeletons for use in public demonstrations and using illustrations, printed and hand drawn, to show his audience key features of the body. What remains to be seen is how this approach to understanding Vesalian changes to public dissection informs our understanding of sixteenth-century anatomy more broadly.

The idea that illustrations might be used to show aspects of the body difficult to see in the body itself, for example, might lead to thinking about anatomical illustrations in the sixteenth century differently. While Vesalius's *Fabrica* provided a comprehensive visual record of virtually every aspect of the human body, other anatomical illustrations of the early sixteenth century were more limited in scope. The most common printed anatomical illustration may have been a skeleton. Berengario, for one, noted that his illustrations of skeletons showed the bones arranged in the whole body in a way that "could not be seen otherwise" except in a specially prepared specimen. A way of seeing the bones as they were arranged in the body itself was certainly important, as we have seen.⁴⁹

Besides the bones, Berengario's other illustrations were of the brain, the veins involved in bloodletting, the muscles and important figures representing female organs of reproduction—topics repeated in a number of other illustrated texts of the time. It is probably no coincidence that most of the topics selected for illustration were the same. It

49. Berengario, *Isagogae*, 71v and 63v.

was not just their significance to anatomy but the difficulty in seeing them in an actual body that prompted the choice.

Even more important than reflections on how other anatomists may have been reflecting the known constraints of public dissections in their illustrations is the way that the additions made by Vesalius may have actually affected his understanding of anatomy. There is perhaps no more striking passage in the *Fabrica* related to this fact than Vesalius's discussion of the *rete mirabile*, the structure of arteries at the base of the brain described by Galen but existing only in some animals and not in humans. Describing how he was fooled at first into accepting the structure's existence in humans, Vesalius noted that he nearly missed the issue because, "I never undertook the *public* dissection of a human head without having available that of a lamb or ox to supply whatever I could not find in the human."⁵⁰

Here, it seems clear that despite his efforts to overcome the limitations of public dissections, or more accurately because of those efforts, Vesalius missed a key anatomical fact. It is a fact, it must be noted, that Berengario had already discovered. Berengario famously concluded there was no *rete mirabile* because he could not find it, despite having dissected a large number of *human* bodies. On the other hand, Berengario did not make the connection between Galen's assertion and animal dissection, while Vesalius did. Berengario certainly dissected animals, but his brain dissection efforts relied on multiple human subjects, while Vesalius' also incorporated animal specimens. Certainly, the different experiences were due in part to Vesalius's emphasis on public dissections and the animal dissections that went with them.

Something similar can be found in Vesalius's work with skeletons. In his description of preparing an articulated skeleton, Vesalius noted that he had made an important discovery about the differences between animals and humans while preparing a pair of skeletons in Bologna in 1540. Vesalius assembled two skeletons for Giovanni Andrea Bianchi, a Bolognese professor of medicine. One skeleton was human, a priest whose body had been acquired surreptitiously. The other was an ape. When Vesalius assembled the two after dismembering the bodies and boiling away the flesh, he discovered that the vertebrae of the ape contained the extra processes that he had seen

50. Quotation in O'Malley, *Vesalius*, 179–80. The emphasis is mine.

described by Galen as a feature of human anatomy—while the vertebrae of the man did not. The ape’s skeleton and the human skeleton observed side-by-side allowed Vesalius to make this discovery; yet Vesalius emphasized that articulated skeletons were important largely in the context of public dissections. Vesalius did not describe assembling the skeletons of ape and man to look for differences between them, but to provide them to Bianchi to use in the manner he had suggested to the readers of the *Fabrica*. His discovery, like that of the *rete mirabile*, was a matter of happenstance resulting from his special preparations for public dissections.⁵¹

In the spirit of alternative ways to understand well-known aspects of Renaissance anatomy, I think it is also worth noting that animals, skeletons, and public dissections were closely interwoven in an illustration famously associated with Vesalius. The much-discussed scene on the title page of Vesalius’s *Fabrica* shows the author conducting a public dissection. Clearly visible in the background stands an articulated skeleton. A dog and a monkey appear in the foreground in the illustration of the first edition, and in the second edition, another animal is added. These elements of the illustration in the *Fabrica* are quite rare in other, earlier dissection scenes studied by historians.⁵² They may have a number of symbolic meanings, but they are also clear representations of key aspects of Vesalius’s approach to conducting public dissections.

At the beginning of this paper, I noted that despite the considerable scholarly attention devoted to the importance of dissection, especially in the case of Vesalius, very little work has been done in examining the interrelationship of its educational and investigative uses. It is clear that Vesalius’s approach to dissection was based in part on his distinct ideas about how anatomy ought to be taught. In the opening pages of the *Fabrica*, for example, Vesalius described his efforts to present anatomical information in the order that it should be learned, as described by Galen—a point he returned to at the beginning of Book

51. Vesalius, *Fabrica*, 78. For a description, see O’Malley, *Vesalius*, 100–1.

52. For example, in Carlino, *Books of the Body*, 8–68 and Park, *Secrets*, 207–59, as well as G. Wolf-Heidegger and A. M. Cetto, *Die Anatomische Sektion in bildlicher Darstellung* (Basel, 1967). Skeletons do figure into numerous medical illustrations in early printed works, but not normally in dissection scenes. A dog does appear in a late fifteenth-century printing of *Le propriétaire des choses* by Bartholomaeus Anglicus which is reproduced in Park, *Secrets*, 130, but it is well groomed and wears an elaborate collar, suggesting that it may not have been destined for the dissection table.

3, where he again pointed out that although the reader may have expected the book to follow one course, he had deliberately conformed to Galen's prescribed order of subjects. As in so many other instances, the methods for learning anatomy were important to Vesalius because they were important to Galen, and they drove his approach to public dissections. Tellingly, Galen's advice about the proper order for learning anatomy appeared in a book that also advised the reader to pay attention to the bones and the muscles and not to neglect them in favor of the internal organs. Certainly, Vesalius made an effort to do just that in his public demonstrations and in the pages of the *Fabrica*.⁵³

But it was in following Galen's advice that Vesalius also encountered Galen's mistakes, identifying where the ancient authority had confused animal and human anatomy, as he himself began to work on animals and humans side-by-side. It is, I think, an open question where and when Vesalius first noticed the differences between animals and humans, but it is certainly clear that some problems that he identified came to light in connection with preparations for and conduct of public dissections. In consequence, we should hesitate before accepting sharp distinctions between the educational and the investigative purposes of anatomical dissection in the sixteenth century.

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53. Vesalius, *Fabrica*, 4 and 257. Galen examined the skeleton of an executed criminal picked clean by scavenger birds, and Vesalius stole the corpse of condemned criminal from outside the city walls of Leuven in addition to preparing the skeletons of other bodies.