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Illustrations from the Wellcome Library

Vesalius's Method of Articulating the Skeleton and a Drawing in the Collection of the Wellcome Library

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One of the recent acquisitions of the Wellcome Library, a sixteenth-century Italian drawing of the bones of the pelvis (Plate 1), is particularly significant because it clearly depicts the copper wires and iron rod used in the method of articulation of the skeleton described by Andreas Vesalius (1514–1564) in the thirty-ninth chapter of the first book of *De humani corporis fabrica*, published in 1543.[1] This procedure was the most detailed yet to have appeared in print and it was further enlivened by its visual demonstration in initial letters decorating the book.[2]

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[1] "Quo artificio humani corporis ossa & cartilagines inspectioni praeparentur", in Andreas Vesalius, *De humani corporis fabrica*, Basel, J Oporinus, 1543, pp. 155–62. An annotated translation is provided by J B de C M Saunders and Charles Donald O'Malley, 'The preparation of the human skeleton by Andreas Vesalius of Brussels', *Bull. Hist. Med.*, 1946, **20**: 433–60; and more recently in Andreas Vesalius, *On the fabric of the human body. A translation of "De humani corporis fabrica libri septem"; Book I: The bones and cartilages*, by William Frank Richardson, in collaboration with John Burd Carman, San Francisco, Norman Publishing, 1998, pp. 370–84. For a commentary on the chapter, see also M Roth, *Andreas Vesalius Bruxellensis*, Berlin, Georg Reimer, 1892, app. X, pp. 462–5; Glauco de Bertolis, 'La preparazione degli scheletri in Andrea Vesalio', *Acta med. Hist. patav.*, 1964–65, **11**: 37–49.

[2] See Samuel W Lambert, 'The initial letters of the anatomical treatise, "De humani corporis fabrica", of Vesalius', in Samuel W Lambert, Willy Wiegand and William M Ivins, Jr, *Three Vesalian essays to accompany the "Icones anatomicae" of 1934*, New York, Macmillan, 1952, pp. 1–24, on pp. 8, 13–14. A new set of initials were cut for the second edition of the *Fabrica* of 1555, with the exception of four large initials which were the same in both editions. Of these, the large "O" initial of putti boiling bones in a cauldron at a hearth (illustrating this article,

To clean the bones, Vesalius advised macerating them in a large cauldron of boiling water in preference to the practice of covering a cadaver with lime, then placing it in a stream of flowing water in a perforated box for several days, as illustrated in the initial letter "C". Following its removal from the box, the skeleton was further cleaned with a knife, leaving the ligaments of the joints untouched. The skeleton was then placed in the sun, the pose being fixed by the drying ligaments. This method was rejected by Vesalius not only because it was "troublesome, dirty, and difficult" but also because it rendered a skeleton unsuitable for instruction as the joints would be obscured by the dried and blackened ligaments.[3] In addition, one could add that while the above process took several days, Vesalius's preferred method could be completed in several hours, depending on the age of the subject. Sweeping aside any lingering stigma stemming from the papal bull of Boniface VIII of 1299, *Detestande feritatis*,[4] which forbade the boiling of bones for the repatriation for burial of the remains of those who had died abroad, Vesalius is as forthright in his chosen means of cleaning the bones of flesh in chapter 39 of book I, as he was in publicizing his use of cadavers stolen from tombs and cemeteries.

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p. 97 and Fig. 5), was used to decorate the first chapter of the first book of both editions of the *Fabrica* and as well as Vesalius's *Epistola, rationem modumque propinandi radicis Chynae decocti* . . ., Basel, J Oporinus, 1546, p. 200. The other initials illustrated in the present article, "C" (p. 100), in which a perforated box holding a cadaver is placed in a running stream and "P" (p. 101), in which putti anatomists articulate a skeleton, are from the first edition. They decorate chapters 39 and 40 ("De ossium numero") of book I respectively, as well as appearing throughout the *Fabrica*.

[3] *Fabrica*, op. cit., note 1 above, p. 155. Charles Estienne, who began writing his *De dissectione partium corporis humani*, Paris, Simon de Colines, 1545, before the publication of Vesalius's *Fabrica*, describes both methods of maceration on pp. 374–75. In Realdo Colombo's posthumous *De re anatomica*, Venice, Nicolo Bevilacqua, 1559, the fourth book on the skeleton concludes with an account of the cleaning and articulation of a skeleton along Vesalian lines. For a history of maceration of bones and their articulation, see Adolf Faller, *Die Entwicklung der makroskopisch-anatomischen Präpierkunst von Galen bis zur Neuzeit*, Basel, S Karger, 1948, pp. 36–53, and Roth, op. cit., note 1, pp. 470–2. A work not cited by Faller or Roth is J Cloquet's thesis for the Faculté de Médecine de Paris, *De la Squelétopée, ou de la préparation des os, des articulations, et de la construction des squelètes*, Paris, Méquignon-Marvis, 1819.

[4] Issued on 27 September 1299, then again on 18 February 1300 (August Potthast, *Regesta pontificum romanorum inde ab anno post Christum natum 1198 ad annum 1304*, 2 vols, Berlin, Rudolph de Decker, 1874–5, vol. 2, nos 24881 and 24914). For the background to the bull, see Elizabeth A R Brown, 'Death and the human body in the later Middle Ages: the legislation of Boniface VIII on the division of the corpse', *Viator*, 1981, **12**: 221–70, and Mary Niven Alston, 'The attitude of the church towards dissection before 1500', *Bull. Hist. Med.*, 1944, **16** (3): 221–38. Although not aimed at the study of anatomy, there is evidence that the bull had an impact on anatomical preparations. Mondino's fourteenth-century text on anatomy, a standard work through to the sixteenth century, acknowledges the usefulness of boiling the bones but avoids it due to the "sin involved" (Charles Singer, *The Fasciculo di medicina, Venice, 1493*, with trans. of the 1482 Latin edition of Bologna, Florence, R Lier, 1925, 2 parts, part 1, pp. 49, 94, 96; see also Alston, op. cit., p. 224, n. 16). This is perhaps why, as Saunders and O'Malley suggest in op. cit., note 1 above, p. 435, the cleaning of the bones of flesh by the use of lime and running water remained a popular practice.

There are several documented instances of Vesalius articulating a skeleton, first as a student and later as an aid to his lectures on Galen's *On the bones* and those based on the *Fabrica*. In Louvain, *c.* 1536, after his studies in Paris had been interrupted by war, Vesalius took the opportunity to articulate his first skeleton when, while looking for bones among the remains of executed criminals left outside the city wall, he came upon a relatively intact and exceptionally dry cadaver, partially cleaned by birds.[5] With the help of his friend, the mathematician, geographer and physician Gemma Phrysius (1508–1555), he secreted the body into Louvain where, after cleaning the bones by boiling them, he constructed the skeleton, replacing missing parts from other sources. In reporting this episode at the end of the thirty-ninth chapter of the *Fabrica*, Vesalius refers to Galen's similar encounter with the remains of a robber whose bones had been cleaned by birds.[6] Aside from this "found" skeleton, the sources, when given, for Vesalius's other documented articulated skeletons were dissected fresh cadavers, the bones obtained in this manner considered more suitable for the purpose.[7] Three plates of the Vesalius's *Tabulae sex* (Venice, B Vitalis, 1538) depict a skeleton that Vesalius had articulated for his students in Padua, and, while lecturing at the University of Bologna in 1540, he articulated the bones of a French priest and those of an ape.[8] By doing so he was able to demonstrate that Galen's description of the lumbar vertebrae was based on non-human anatomy. With this sort of comparison in mind, Vesalius concludes his chapter by suggesting that students should also have the bones and skeletons of animals to hand and, with reference to Galen, particularly those of apes and dogs.[9] Although Vesalius clearly believed that disarticulated bones provide a better view of their sinuses and heads, articulated skeletons were useful for teaching and display purposes, and Vesalius attributed to his own efforts the presence of articulated skeletons in universities.[10] A skeleton articulated by Vesalius is partially preserved to this day in Basel. While in that city to oversee the printing of the *Fabrica*, he was given in May of 1543 the body of an executed bigamist and attempted murderer, Jacob Karrer, to dissect. Vesalius articulated Karrer's skeleton and presented it to the University of Basel.[11]

[5] *Fabrica*, op. cit., note 1 above, pp. 161–2.

[6] Galen's other observation of an entire human skeleton was that of a body swept from a tomb by a stream and deposited on a river bank. For both, see Galen, *De anatomicis administrationibus*, in *idem*, *Opera Omnia*, ed. C G Kühn, 20 vols, Leipzig, C Cnobloch, 1821–33, repr. Hildesheim, G Olms, 1964–65, vol. 2, pp. 221–2.

[7] See note 17, below.

[8] *Fabrica*, op. cit., note 1 above, pp. 76, 78.

[9] Ibid., pp. 162. This is one function of Vesalius's illustration of a human skull resting upon that of a dog, used twice in the *Fabrica* (ibid., pp. 36 and 47).

[10] Ibid., pp. 159, 162.

[11] For the life and deeds of Karrer and the later history of his skeleton, see Gerhard Wolf-Heidegger, 'Vesals Basler Skeletpräparat aus dem Jahre 1543', *Verh. naturf. Ges. Basel*, 1944, **55**: 210–34; Erich Hintzche, 'Die älteste anatomische Präparat', *Ciba-Z.*, 1946, **9**: 3686; C D O'Malley, *Andreas Vesalius of Brussels, 1514–1564*, Berkeley and Los Angeles, University of California Press, 1964, pp. 137–8, pl. 24.

ontemporary accounts of Vesalius's lectures in Pisa in 1544 indicate the value he placed on an articulated skeleton as a lecturing aid. According to a letter requesting that more human and animal bodies be sent from Florence, Vesalius had to interrupt his lecture on the bones at the University of Pisa when the ribs of a cadaver he was dissecting proved to be too corrupt to serve for the skeleton he was in the course of articulating.[12] This account is confirmed in the *Letter on the china root* of 1546, where he relates that there were insufficient bones when he began his anatomy at Pisa and that he composed a skeleton from the body of a nun sent from Florence and from that of a hunchback girl of seventeen, whose body had been taken by his students from a cemetery in Pisa.[13] The fact that both these subjects had been virgins caused him to remark on an earlier dissection of a virgin in Padua, that of a six-year-old girl whose skeleton he had also articulated.

The systematic description in book I, chapter 39 of how to free the bones from the flesh before placing them in the cauldron of boiling water and in what order, is clearly the method that Vesalius followed himself.[14] Care was to be taken so as not to break any of the ribs or the vertebral processes of the spine, and the cartilages were to be set aside. The vertebral column was to be separated into three sections, lumbar, thoracic and cervical. To avoid confusing the bones of the hands and feet, Vesalius recommended that they be removed from the cauldron whole and then wrapped in four separate pieces of paper until needed. All the bones, when removed from the water, are then cleaned with a knife. After counting them and ensuring that they are all present, Vesalius suggests placing them in a second cauldron of clean boiling water and finally going over them with a rough cloth.

Despite the manual and unpleasant nature of the task, the cleaning of the bones was not to be relegated to an assistant unfamiliar with the skeleton,[15] for great caution was needed to avoid damage to the bones, the loss of bones and cartilage, and the detachment of an epiphysis. Vesalius urges vigilance in cleaning the bones throughout the chapter and elsewhere in the *Fabrica*. As he remarks in chapter 28 on the sesamoid bones in the hand, these ossicles may be missed by the unobservant and consequently thrown out with the ligaments.[16] As a further encouragement, the cleaning of the bones is also promoted as a good opportunity for their detailed study.

[12] See letter of 30 January 1544 (modern style) of Vincenzo Riccobaldi in Pisa to Pier Francesco Riccio, Duke Cosimo de'Medici's personal secretary, in Florence, in Andrea Corsini, *Andrea Vesalio nello studio di Pisa* (estratto dal Volume pubblicato nel XXX anno di Direzione sanitaria del Prof D Barduzzi delle RR Terme di S Giuliano), Siena, S Bernardino 1915, 3–21, pp. 5–6; discussed in O'Malley, op. cit. at note 11, p. 200.

[13] Vesalius, *Epistola,* op. cit., note 2 above, pp. 140–1. See O'Malley, op. cit., note 11, p. 201.

[14] *Fabrica*, op. cit., note 1 above, pp. 155–9.

[15] Ibid., p. 157.

[16] Ibid., p. 126.

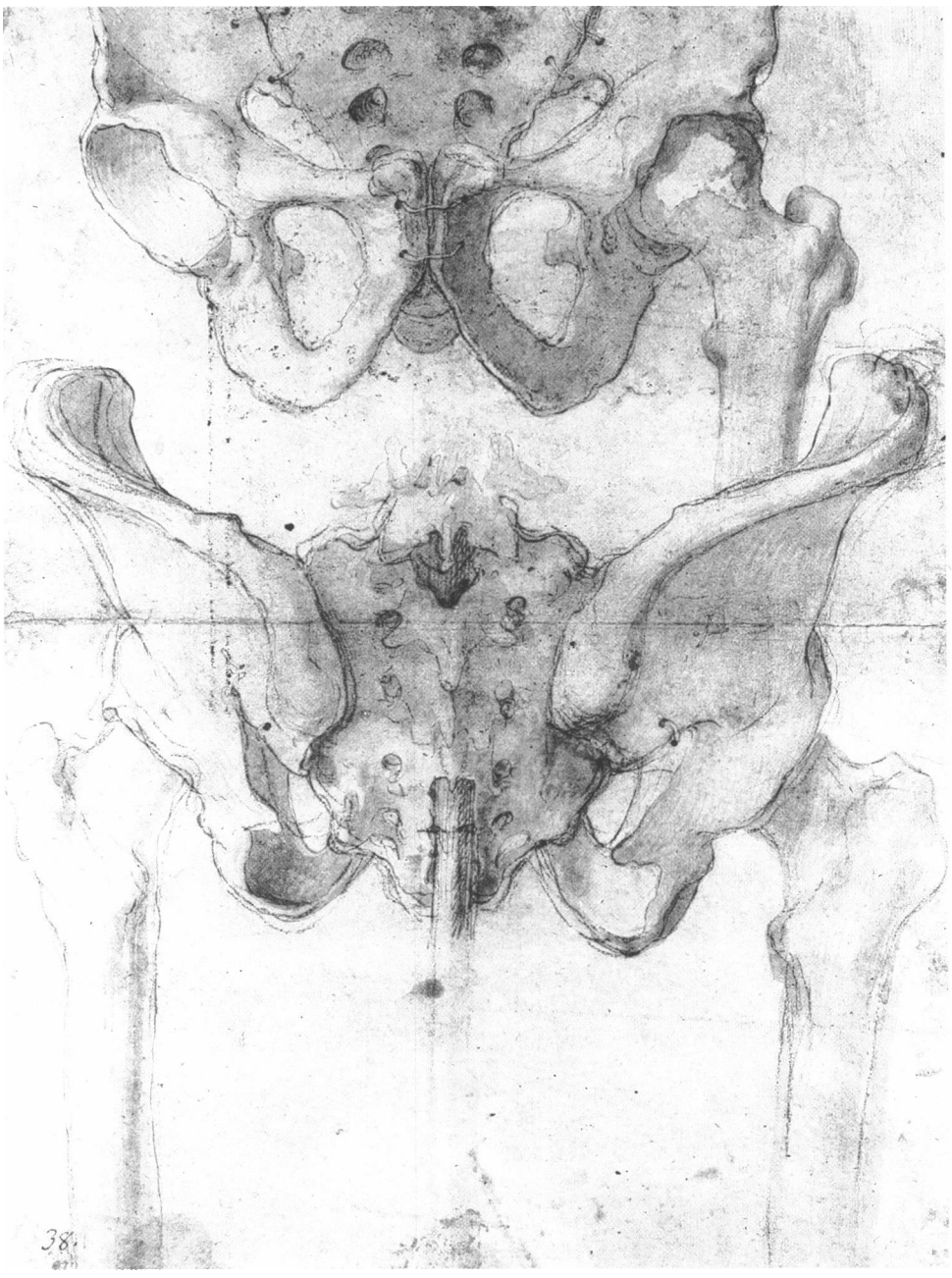

Plate 1: Anonymous Italian, sixteenth century, The bones of the pelvis, seen from the front and the back, pen and brown ink and wash over black chalk. (Wellcome Library, London, cat. no. 39346 recto.)

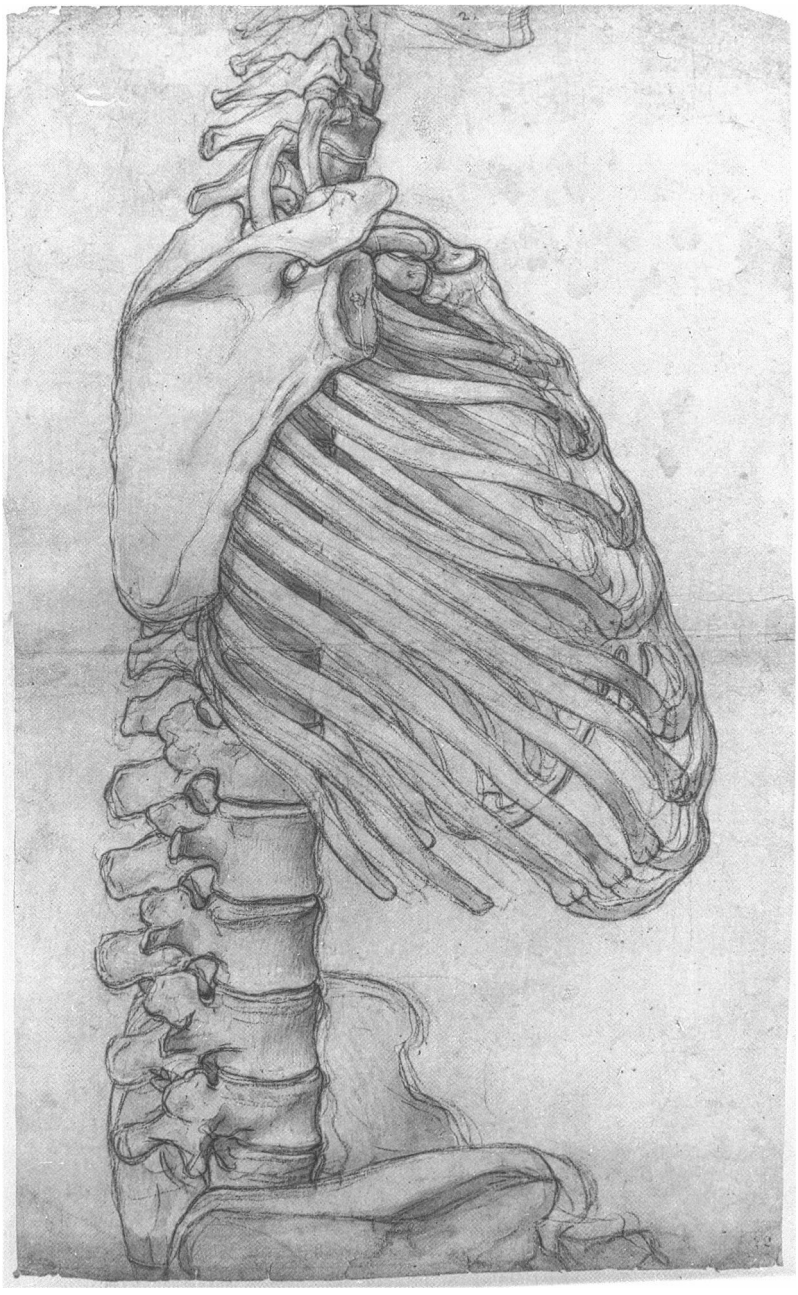

Plate 2: Anonymous Italian, sixteenth century, Skeleton torso, with hip bones, in right profile, pen and ink and wash over black chalk. (Biblioteca Ambrosiana, Milan, Cod F 231 inf n 22.)

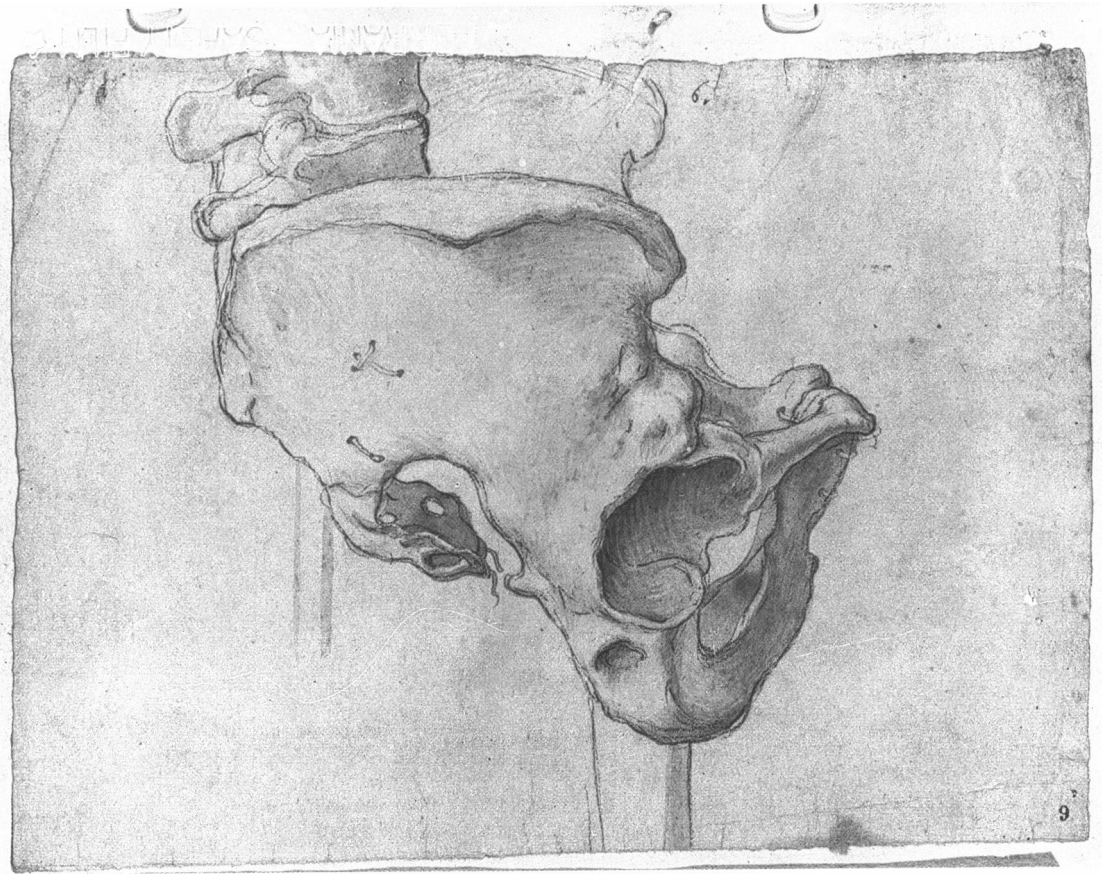

Plate 3: Anonymous Italian, sixteenth century, Pelvis and lumbar vertebrae, in right profile, pen and ink and wash over black chalk. (Biblioteca Ambrosiana, Milan, Cod F 231 inf n 9.)

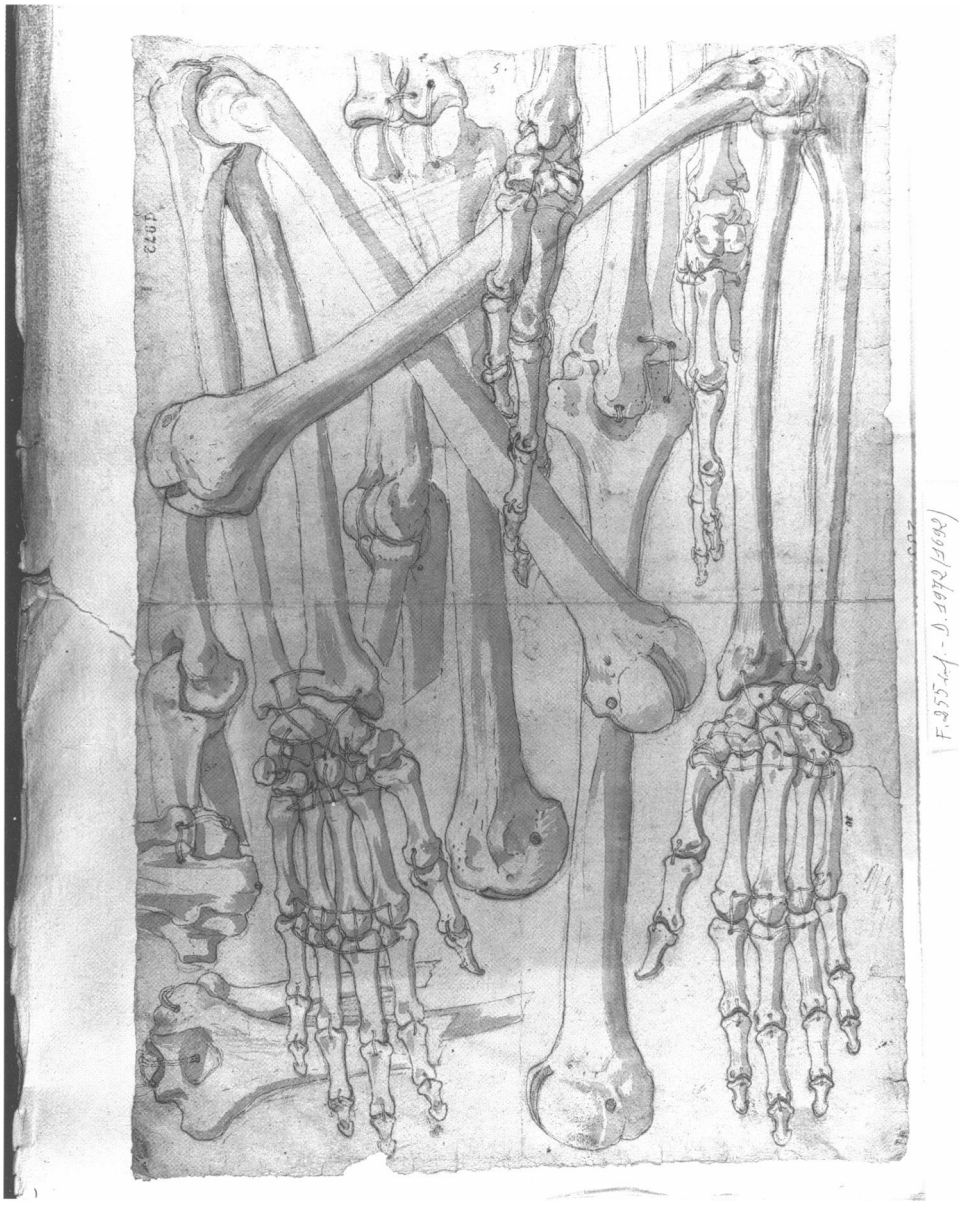

Plate 4: Anonymous Italian, sixteenth century, Bones of arms and hands, pen and ink and wash over black chalk. (Biblioteca Ambrosiana, Milan, Cod F 255 inf n 1972.)

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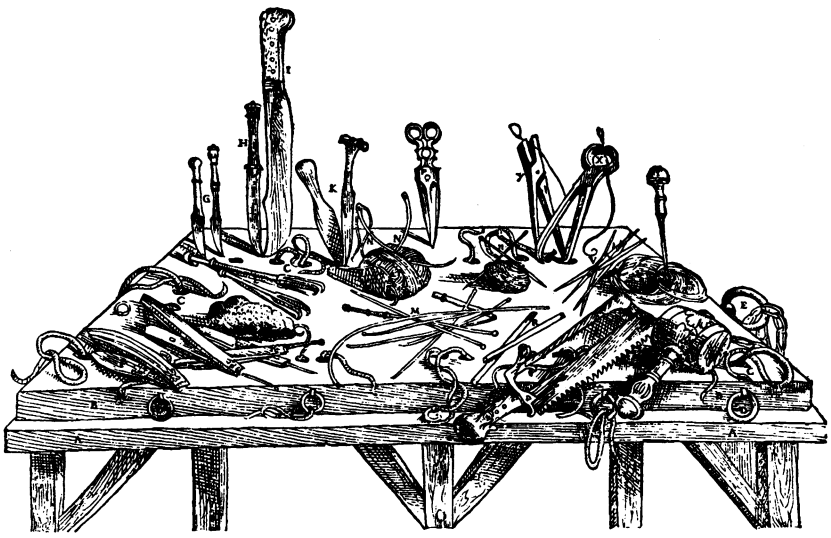
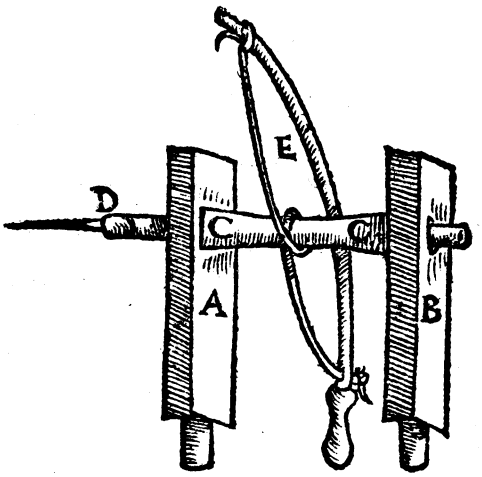


Figure 1: Anatomical instruments on a vivisection table, woodcut illustration to Andreas Vesalius, *De humani corporis fabrica*, Basel, J Oporinus, 1543, bk 2, ch. 7, p. 235 (misprinted p. 237). (Wellcome Library, London.)

romptly after cleaning, work on articulating the skeleton was started so that, before they hardened, the bones could be more easily perforated with an awl and tied together with copper wire. Bones dissected from a fresh cadaver were the most suitable for articulation. Those taken from tombs were too hard and lacking in their cartilages, while disinterred bones or those heaped in ossuaries were liable to decay and losses.[17] Vesalius suggested using two different thicknesses of wire, which could be warmed in the fire so that they were easier to work with. Coils of copper wire, an awl and short iron rods, and a pair of pliers and pincers to twist and cut the wire,

[17] Ibid., p. 159. An example which Vesalius gives of such a loss is found in his chapter 'On the twelve bones of the upper jaw, including the nasal bones' (bk I, ch. 9, p. 40), in which the lacrimal bone of the orbit, which he calls "the second maxillary bone", is described as easily lost from skulls dug up from the ground because of the nature of its articulation, but which can be safely preserved if a skull is boiled.



Hac figura inſtrumentum id expreßimus, quo duriora oſſa leui negotio perforantur. Significet itaq; A & B duos ſtipites, qui menſæ aut ſcamni alicuius angulo poſſunt infigi. C, C axim. D axis partem, cui ferrum, ſubulæ in modum inditur. E uerò arcu-lum, quo axis circũuoluitur.

Figure 2: Awl for piercing bones, woodcut illustration to Andreas Vesalius, *De humani corporis fabrica*, Basel, J Oporinus, 1555, bk 1, ch. 40, p. 196. (Wellcome Library, London.)

all equipment necessary for the articulation of the skeleton, were included in Vesalius's illustration of anatomical instruments, and are visible on the right side of the vivisection table in the woodcut that heads the seventh chapter of book II (lettered: S, T, V, X, Y) (Figure 1). In one of the changes in the second edition of 1555, this chapter was moved to become the concluding chapter of book I, making it easier for readers of the now immediately preceding chapter on the articulation of the skeleton to consult (chapters 40–41 in the 1555 edition). Another change to the 1555 edition of the *Fabrica* was the addition of a woodcut in-text illustration demonstrating the type of awl to be used in preparing the bones to receive the wire (Figure 2).

The construction of the skeleton began with the bones of the feet.[18] The bones of the leg were next put together. In addition to wire, the tibia and femur were connected with a small rod that fixed the knee joint. The feet were then fixed to a rotatable wooden disk, which could be set in a box if desired. Once the legs were attached to the feet and the femurs inserted into the acetabula of the pelvis, one could then measure the height from the wooden disk to the sacrum and so judge the necessary length of the metal rod that was to be inserted in the sacrum, at a point enlarged with a knife, and threaded up the spine to hold the vertebrae in place and support the weight of the skeleton. A further support is recommended in the form of an upright, such as a javelin or scythe, to be held by the skeleton, as seen in the title pages to the first and second editions of the *Fabrica*, or in the first skeleton plate in

[18] Ibid., p. 159. See ibid., pp. 159–61, for the articulation of the bones.

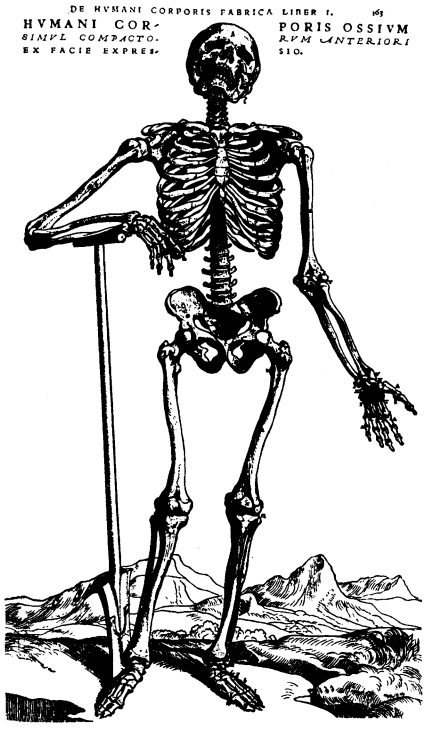


Figure 3: First skeleton plate, woodcut illustration to Andreas Vesalius, *De humani corporis fabrica*, Basel, J. Oporinus, 1543, bk 1, p. 163. (Wellcome Library, London.)

which the skeleton rests his arm on a spade (Figure 3). The rest of the bones were connected with copper wire and the preserved cartilages attached.

In the Wellcome Library drawing[19] (Plate 1), the bones of the pelvis and the top of the femur are drawn in two views, one above the other. The drawing at

[19] Catalogue no. 39346. Recto: pen and brown ink and wash over black chalk; the number "38." appears at the lower left. 37.1 × 28.4 cm. Creased at the centre from a horizontal fold. On the verso are three weak sketches: the buttocks and thighs in graphite; a pair of crossed legs, seen from the front, in red chalk; a foreshortened reclining figure with a raised left leg, seen from below, in black chalk. At the top of the verso of the sheet there is a stamp in faded black ink in the form of a design for a corner of a mount or frame, decorated with a flower (not in F Lugt, *Les Marques de collections de dessins et d'estampes*, Amsterdam, Vereenigde Drukkerijen, 1921; *idem*, *Supplément*, The Hague, Martinus Nijhoff, 1956). Next to this is a watermark of a pair of scissors, similar to but not exactly the same as fifteenth-century examples given in Briquet and in Heawood (C M Briquet, *Les Filigranes. Dictionnaire historique des marques du papier*, 3rd ed., 4 vols, Amsterdam, The Paper Publications Society, 1968, "ciseaux de tendeur" type, nos 3762–67; Edward Heawood, *Watermarks, mainly of the 17th and 18th Centuries*, Hilversum, The Paper Publications Society, 1950, pl. 497, no. 3719). The drawing was sold at London, Phillips, Old Master Drawings, 2 July 1997, lot 123, as "Florentine School, *c.* 1540". Previously offered for sale at New York, Sotheby's, Old Master Drawings, 8 January 1991, lot 57, and at London, Sotheby's, Old Master Drawings, 4 July 1988, lot 38, catalogued in both as "Florentine school, first half of the sixteenth century".

the top of the sheet is of the hip bones and the sacrum, seen from the front, with the head of the left femur inserted into the acetabulum of the left hip bone. Below is a more complete view of the same bones seen from the back, including some of the lumbar vertebrae and the supporting rod inserted into the sacrum. Here both femurs are represented and the right femur could be a complementary addition supplied by the artist or a record of a later step in the articulation of the skeleton. In the top study, two wires secure the pubic bones, and four more tie the sacrum to the hip bones, a pair on either side. Although Vesalius advises the reader to join the pubic bones with its cartilage,[20] in practice it appears that he did at times use wire to join these bones, in a manner similar to the Wellcome drawing. Roth, in his 1892 description of the surviving parts of the skeleton that Vesalius had articulated in Basel, observes that in the pubic bones there are small, empty old boreholes to receive wire.[21] The wiring of the sacrum in the drawing at the top of the Wellcome sheet concurs with Vesalius's advice "that the ilia must be joined to the sides of the sacrum by coarse wire."[22] Further wires are visible in the lower drawing, where a criss-cross of wires appears in the body of the right ilium and a wire below this near the greater sciatic notch. On the left hip bone, in the same general area, three wires can be seen. The lower of these is likely to be one of those attached to the sacrum. The rod, which has been inserted through a perforation made in the sacrum, is a detail omitted in the top view. The horizontal line that appears just below the point where the rod enters the sacrum may be an indication of the copper wire Vesalius suggests be wrapped around the rod, if necessary, to further support the sacrum and prevent it from slipping.[23] The forward facing angle of orientation of the pelvic bones, which does not reflect their position in nature in a standing skeleton, is perhaps a result of the articulation process and it is also found in representations of the skeleton in the *Fabrica* and the *Tabulae sex* and later anatomical illustration.[24]

The several attempts made by the artist to establish the outlines of the bones, particularly in the lower study, give the Wellcome sheet a tremulous feeling and the application of a brown wash lends a particularly pleasing sense of volume and light to the bones. These same qualities are found in a related series of seven drawings of articulated skeleton parts in the collection of the Biblioteca

[20] *Fabrica*, op. cit., note 1 above, pp. 157, 158, 159.

[21] Roth, op. cit., note 1 above, p. 468.

[22] *Fabrica*, op. cit., note 1 above, p. 159; trans. by William Frank Richardson, op. cit., note 1 above, p. 379.

[23] *Fabrica*, op. cit., note 1 above, p. 161.

[24] See Melvin W Stromberg and David J Williams, 'The misrepresentation of the human pelvis', *J. Biocommun.*, 1993, **20** (2): 14–28, on p. 15, who document this surprisingly enduring error.

Ambrosiana in Milan.[25] These drawings, all with visible connecting wires and one showing a supporting rod, are by the same hand as the Wellcome sheet and in the same media of pen and ink and wash over black chalk. The seven Ambrosiana drawings are separated between two bound volumes, Cod F 231 inf and Cod F 255 inf, and are all pasted down. There are three impressive views of a skeletal torso with scapulae and one of the pelvis (Plates 2 and 3). The remaining sheets are of the bones of the feet and lower leg, of the bones of the hands and arm (Plate 4), and studies of the femur and the patella, all drawn from several viewpoints. In these drawings, the wiring of the ribs to the costal cartilages and to the vertebrae is distinctly seen, as is that of the sternum to the first rib and to the clavicles, the scapulae to the ribs and the clavicles to the scapulae. So is the wiring of the joints of the elbow, the wrist, and the ankle. The elaborate wiring seen in the drawings of the hands and feet is necessitated by the numerous, small bones of which they are comprised. The Wellcome and Ambrosiana drawings, by an unidentified hand, should be dated to the second half of the sixteenth century, after the publication of the *Fabrica* in 1543 and the wider adoption of Vesalius's method of articulating the skeleton.

It is evident that the Ambrosiana drawing of the pelvic bones with two lumbar vertebrae seen in right profile (Plate 3) was drawn from the same subject as the Wellcome drawing since the positioning of the wires is identical in both sheets. The pair of wires that unite the pubic bones in the upper study of the Wellcome drawing is just apparent at the right of the Milan drawing, seen in profile. More plainly, one can recognize the repetition of the criss-cross of wires and the single wire below in the body of the right ilium that is present in the lower study of the Wellcome sheet. What appear to be two further wires, not seen in the Wellcome sheet, trail from the end of the sacrum. In a direct line below the spine is a faint indication of the supporting rod. The right femur is absent, as with the upper study of the Wellcome sheet, and it is the continuation of the left femur that we see emerging below the right ischium.

[25] *Skeleton torso, with hip bones, in right profile*, Cod F 231 inf n 22, ND cat. no. 5023, 48 × 28.8 cm.; *Pelvis and lumbar vertebrae, in right profile*, Cod F231 inf n 9, ND cat. no. 5024, 22.4 × 29.3 cm.; *Bones of the leg and foot*, Cod F 255 inf n 1971, ND cat. no. 4360, 41.3 × 29.2 cm.; *Bones of arms and hands*, Cod F 255 inf n 1972, ND cat. no. 4361, 43 × 29.4 cm.; *Studies of the femur and patella*, Cod F 255 inf n 1973, ND cat. no. 4362, 43 × 29.2 cm.; *Skeleton torso and sacrum, seen from the back, the hip bones lightly indicated*, Cod F 255 inf n 1974, ND cat. no. 4363, 48.3 × 31.5 cm.; *Skeleton torso and sacrum, seen from the front*, Cod F 255 inf n 1975, ND cat. no. 4364, 46.2 × 31.5 cm. All in pen and ink and wash over black chalk. With the exception of Cod F231 inf n 9, which is likely to have once been a larger sheet, the drawings are of similar dimensions and have a horizontal crease similar to the Wellcome drawing (cat. no. 39346). The "ND" catalogue numbers refer to the University of Notre Dame online catalogue of the Ambrosiana Library collection of manuscripts and drawings, currently in progress (www.nd.edu/~italnet/AMBROS). The drawings under discussion are all described as "Lombard, Milanese" and dated *c.*1600–4. The drawings in Cod. F231 inf and F255 inf are given a general dating to the seventeenth century in Angelo Paredi, *Storia dell'Ambrosiana*, Milan, Biblioteca Ambrosiana, 1981, p. 111.

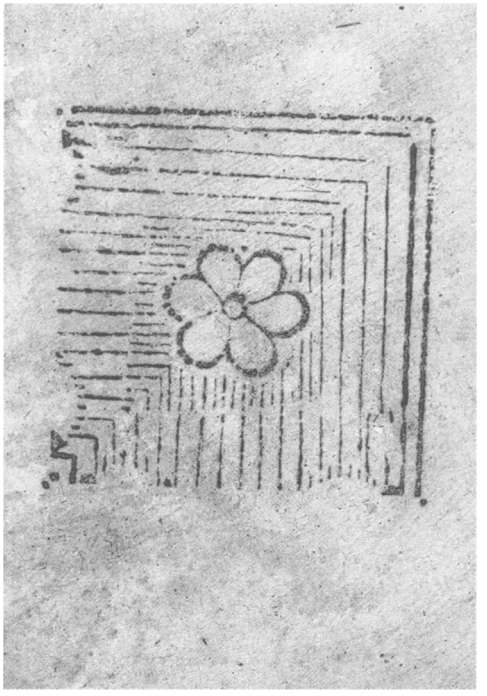


Figure 4: Detail of stamp on verso of plate 1, Wellcome Library, London, cat. no. 39346 verso. (Wellcome Library, London.)

Not only are the Ambrosiana drawings and the Wellcome sheet by the same hand and drawn from the same skeleton, it is likely that they were all once in the same collection. Although they are pasted down, showing through from the verso of several of the Biblioteca Ambrosiana sheets is an unidentified stamp, similar to that found on the verso of the Wellcome sheet, in the form of a design for a corner of a mount or frame, bearing a flower (Figure 4).[26] The Biblioteca Ambrosiana was founded by Cardinal Federico Borromeo (1564–1631), whose donation of drawings in 1618 was followed by numerous others in the following centuries.[27] The specific provenance of the Ambrosiana drawings under discussion is not known, nor is that of the Wellcome sheet, beyond its recent appearance at auction.[28] Until further information comes to light regarding the stamp that the drawings share, their

[26] The drawings in which the mark is visible are: Cod F 255 inf n 1971; Cod F 255 inf n 1972 (Plate 4); Cod F 255 inf n 1974. For the Wellcome stamp, see note 19 above.

[27] Robert Randolf Coleman (ed.), *Renaissance drawings from the Ambrosiana*, University of Notre Dame, 1984.

[28] See note 19, above.

provenance and how and when the Wellcome sheet came to be separated from the Biblioteca Ambrosiana drawings will remain unknown.

The Wellcome drawing and those in the Biblioteca Ambrosiana present a record of an articulation in progress. The drawings document different parts of a skeleton in the process of being assembled. The bones of the arm are not yet attached, and a looped wire hook, seen in two of the drawings in the Ambrosiana, has been set in the glenoid cavity of the scapulae ready to accept the head of the humerus (Plate 2).[29] In another sheet of studies in the same collection which has several views of the bones of the arm and hand wired together, still to be connected to the skeleton (Plate 4), the head of the humerus has been bored and grooved to accept the attachment of this wire hook. Plates 1 and 3 have drawings of the pelvic bones to which the right femur has not yet been attached. In the Ambrosiana drawing of a skeletal torso viewed from the front,[30] several wires are seen trailing from holes drilled along the periphery of the sacrum. These wires would be used to attach the sacrum to the hip bones, as has been done in the Wellcome sheet (Plate 1).

The detail of articulating wires visible in the Wellcome drawing and those in the Ambrosiana Library are rarely seen in early representations of skeletons. While early drawings and prints of skeletons abound, done, for example, by artists in the course of their study of anatomy or in connection with funerary decorations, the means by which the object of their study is kept together is regularly omitted.[31] This is also the case for most anatomical prints of skeletons, including those of Vesalius (Figure 3), in which the desire for the appearance of animation and an elegant pose demanded that the mechanisms by which the skeleton was supported, beyond the occasional staff or scythe, be absent. One exception is the illustration of bones found in the plates to Govard Bidloo's *Anatomia humani corporis* published in Amsterdam in 1685. Engraved after drawings by Gérard de Lairesse (1640–1711), these illustrations are noteworthy for treating the props of dissecting rooms, such as pins, probes, knives and string, with an attention to detail in the tradition of Dutch still-life painting. In the illustration of the bones of the feet and, to a lesser extent, in that of the hand, connecting wires are clearly visible.[32] The highly animated plates of the full-length adult skeletons in the same book, however, do not exhibit any articulating wires. Another rare representation of articulating wires in skeletons is found in the background of the *Anatomy lesson of Dr Willem van der Meer*,

[29] Cod F 231 inf n 22; Cod 255 inf n 1975.

[30] Cod F 255 inf 1975.

[31] See M Cazort, M Kornell and K B Roberts, *The ingenious machine of nature: four centuries of art and anatomy*, exh. cat., Ottawa, National Gallery of Canada, 1996, nos 33–34, 41a, 44; Roberto Paolo Ciardi and Lucia Tongiorgi Tomasi (eds), *Immagini anatomiche e naturalistiche nei disegni degli Uffizi Secc. XVI e XVII*, exh. cat. no. 40, Florence, Uffizi, Gabinetto Disegni e Stampe, 1984, nos 22–25, figs 29–32; no. 42, fig. 51; no. 45, fig. 52; nos 38–39, figs 42–43.

[32] Govard Bidloo, *Anatomia humani corporis*, Amsterdam, published by the widow of Joannes van Soemeren, the heirs of Joannes van Dyk, and Henry Boom and the widow of Theodore Boom, Amsterdam, 1685, pl. 105, figs 1–2; pl. 97, figs 1–2.

a painting by Michiel and Pieter van Mierevelt dated 1617.[33] An example of the omission of the mechanisms of articulation in the representation of skeletons as the product of selective eye of the artist is found in two seventeenth-century prints made after the same design by Johannes Woudanus depicting the anatomy theatre at Leiden. In one of these, Willem Swanenburgh's print of 1610, the stabilizing rods of the human and animal skeletons decorating the theatre are seen, whereas in a print attributed to Bartholomeus Dolendo of *c.* 1609, those of the human skeletons have been omitted.[34]

The artist responsible for the Wellcome and Ambrosiana drawings was present while the skeleton was being articulated. There are several documented instances of contact between artists and anatomists that would allow for the opportunity of such an occasion. One well known friendship is that of the sixteenth-century Italian anatomist, Realdo Colombo (*c.*1515–1559) with Michelangelo (1475–1564). As recounted in the artist's biography, written by his pupil Condivi and published in his subject's lifetime, Colombo and Michelangelo together dissected the body of a Moor at Condivi's house.[35] Other such friendships can be noted. According to the artist and author of the *Lives of the artists*, Giorgio Vasari (1511–1574), the sculptor Fra Giovanni Agnolo Montorsoli (*c.*1506–1563) while in Genoa became friendly with doctors, "helping one another, and carrying out many anatomies on human bodies".[36] The anatomist Vidus Vidius, or Guido Guidi (1509–1569), befriended the sculptor Benvenuto Cellini while they were both in Paris and under the patronage of Francis I.[37] It has not been noted that Vasari also knew Vidius. In several letters written in the early 1560s, Vasari refers to him in friendly terms, sometimes identifying him as the Provost of Pescia, a benefice that had been bestowed upon Vidius by Duke Cosimo.[38] In 1561, Vidius,

[33] Delft, Stedilijk Museum het Prinsenhof, inv. no. B112. See N Middlekoop, *et al.*, *Rembrandt under the scalpel. The anatomy lesson of Nicolas Tulp dissected*, exh. cat., The Hague, Maritshuis, 1998, p. 16, fig. 9.

[34] These prints, along with others of the Leiden anatomy theatre, are illustrated in G Wolf-Heidegger and Anna Maria Cetto, *Die anatomische Sektion in bildlicher Darstellung*, Basel and New York, S Karger, 1967, nos 302 and 301.

[35] Ascanio Condivi, *Vita di Michelagnolo Buonarroti*, Rome, Antonio Blado, 1553, second printing, verso of second of two additional folios, inserted between fols 42 and 43. For Colombo and Michelangelo, see E D Coppola, 'The discovery of the pulmonary circulation: a new approach', *Bull. Hist. Med.*, 1957, **31**: 44–77, pp. 55–7.

[36] Giorgio Vasari, *Le vite de' più eccellenti pittori scultori ed architettori*, Florence, Giunti, 1568, ed. G Milanesi, 9 vols., Florence, Sansoni, 1906, repr. Florence 1981, vol. 6, p. 648.

[37] On Vidius, who was the grandson of the fifteenth-century Florentine artist Domenico Ghirlandaio, see Salvino Salvini, *Fasti consolari dell'Accademia Fiorentina*, Florence, Giovanni Gaetano Tartini and Santi Franchi, 1717, pp. 115–23, and W Brockbank, 'The man who was Vidius', *Ann. R. Coll. Surg. Engl.*, 1956, **19**: 269–95.

[38] Herman-Walther Frey (ed.), *Der literarische Nachlass Giorgio Vasaris: Neue Briefe von Giorgio Vasari*, Burg bei Madeburg, August Hopfer, 1940, vol. 3, nos ii, v, viii, ix, xi, xiv, xv, xxv. Frey, apparently unaware of Vidius's medical career, identifies him, as Vasari does, only as "Messer Guido Guidi, Proposto di Pescia" (ibid., no. viii). On Duke Cosimo's conferral of this benefice upon Vidius, see Salvini, op. cit., note 37 above, p. 117.

then professor of medicine at Pisa, wrote to the artist to advise him that the dissection he wanted to attend was about to take place.[39]

There is also the possibility that the drawings were made at the request of an anatomist. In addition to the employment of artists specifically for the production of illustrations for books, their skills were also used to record dissections. The anatomist Julius Casserius (1561–1616), in his description of the muscles of the ear, notes that these were drawn on 7 March 1593 by the German artist Joseph Murer, whom Casserius employed "for the purpose of painting anatomical illustrations" and who was at the time living in Casserius's house.[40] Perhaps some similar task was the purpose that caused Vasari, after witnessing the dissection in Pisa, to leave behind his assistant Jacopo Zucchi (*c.*1540–*c.*1596), to provide drawings "necessary to the doctors".[41]

The skeleton was considered an essential part of the artist's study of anatomy—the sculptor Cellini wrote a treatise demanding that the young artist draw and memorize each individual bone and then the entire skeleton—and it is not impossible that an artist articulated and drew a skeleton himself.[42] The Florentine artist Alessandro Allori (1535–1607) kept a room in the cloisters of San Lorenzo in the early 1570s for the purposes of dissection and he is documented as receiving a body of an executed criminal in 1570.[43] He paid particular care to the skeleton as is evidenced by his series of drawings of skeletons which have been connected to his manuscript treatise on drawing and anatomy.[44] The numerous skeleton parts strewn across the room of the Florentine academy of the sculptor Baccio Bandinelli (1493–1560), in

[39] Guidi's correspondence with Vasari is recorded in the latter's letter to Duke Cosimo de'Medici of 19 December 1561, published in Karl Frey (ed.), *Der literarische Nachlass Giorgio Vasaris*, Munich, Georg Müller, 1923, vol. 1, no. ccclvi, p. 648. Karl Frey identifies the Guidi that Vasari speaks of as a ducal secretary, Jacopo Guidi da Volterra (ibid., p. 650, n. 1), but it is certainly Guidi/Vidius, the anatomist. Vasari was also friendly with the Aretine physician, Baccio Rontini, and in a letter to him of 1537, Vasari refers to his own previous experience in dissection and requests the loan of an anatomy book (ibid., no. xxvi, p. 80). In the *Vite*, Vasari makes passing mention to dissections that he made together with the artist Francesco Salviati as a young man in Rome, op. cit., note 36 above, vol. 7, p. 13.

[40] Julius Casserius, *De auris auditus organi*, Ferrara, V Baldinus, 1600, p. 79. p. 290 (part of Casserius's *De vocis auditusque organis historia anatomica*, Ferrara, V Baldinus, 1600–1601). Casserius does not identify the artist responsible for the plates of this work but Choulant, on the basis of this remark, has assigned them to Murer, who may be identified with the Swiss painter of the same name. See Ludwig Choulant, *History and bibliography of anatomic illustration*, trans. and ed. by Mortimer Frank, New York and London, Hafner, 1962, p. 223.

[41] Vasari, in letter of 6 January 1562 (modern style), writing from Empoli to Vincenzo Borghini in Poppiano, in Frey, op. cit., note 39 above, no. ccclviii, p. 652.

[42] Benvenuto Cellini, *Sopra i principii e 'l modo d'imparare l'arte del Disegno*, in P Barocchi (ed.), *Scritti d'arte del Cinquecento*, 3 vols, Milan and Naples, Riccardo Ricciardi, 1971–77, vol. 2, pp. 1933–40.

[43] Filippo Baldinucci, *Notizie dei Professori del disegno*, Florence, 1681–1728, F. Ranalli (ed.), Florence, V Batelli, 1845–1847, 7 vols, repr. Florence, 1974–1975, vol. 3, pp. 235–36; p. 525; vol. 7, p. 41; Samuel Y Edgerton, Jr., *Pictures and punishment. Art and criminal prosecution during the Florentine Renaissance*, Ithaca and London, Cornell University Press, 1985, p. 159, n. 48.

[44] See M Kornell in Cazort, *et al.*, op. cit., note 31 above, no. 44, with further bibliography.

a print by Enea Vico (1527–1567) of the 1540s, could be seen as an allusion to the importance of anatomy in an artist's education.[45] Whatever the genesis and authorship of the Wellcome and Ambrosiana drawings, they remain a fascinating and exceptional early record of the Vesalian method of constructing the human skeleton.

Figure 5: Decorated initial letter, woodcut, Andreas Vesalius, *De humani corporis fabrica*, Basel, J Oporinus, 1543, bk 1, ch. 1, p. 1. (Wellcome Library, London.)

[45] Ibid., no. 35. For early academy scenes with artists drawing from skeletons, see ibid., nos 36, 40–41.