

# Executions and scientific anatomy

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## Abstract

The very word “anatomy” tells us about this branch’s connection with dissection. Studies of anatomy have taken place for approximately 2,300 years already. Anatomy’s birthplace lies in Greece and Egypt.

Knowledge in this specific field of science was necessary during surgical procedures in ophthalmology and obstetrics. Embalming took place without public disapproval just like autopsies and manipulation with relics. Thus, anatomical dissection became part of later forensic sciences. Anatomical studies on humans themselves, which needed to be compared with the knowledge gained through studying procedures performed on animals, elicited public disapprobation and prohibition. When faced with a shortage of cadavers, anatomists resorted to obtaining bodies of the executed and suicide victims – since torture, public display of the mutilated body, (including anatomical autopsy), were perceived as an intensification of the death penalty.

Decapitation and hanging were the main execution methods meted out for death sentences. Anatomists preferred intact bodies for dissection; hence, convicts could thus avoid torture. This paper lists examples of how this process was resolved. It concerns the manners of killing, vivisection on people in the antiquity and middle-ages, experiments before the execution and after, vivifying from seeming death, experiments with galvanizing electricity on fresh cadavers, evaluating of sensibility after guillotine execution, and making perfect anatomical preparations and publications during Nazism from fresh bodies of the executed.

## STUDY OF HISTORICAL MATERIALS

Death is an inseparably inevitable part of life. The contrast of a freshly preserved body, the immediate encounter with a dead body can be rationalized in many ways, but it is generally connected with unpleasant emotions. Dead bodies were buried according to tradition as early as in the Palaeolithic; to bury the dead is one of the seven Christian Corporal Works of Mercy. In contrast, in war the dead bodies of enemies were dishonoured: Achilles lets Hector’s corpse get dragged by a horse in

Iliad, similarly Creon in Sophocles’ Antígona forbids burying Polyneices.

Executions are a human device, the most cruel means are denoted as bestial, but in this area the animal exemplars are missing; human wit here has worked at full throttle for thousands of years.

Taking life by lawful means was often executed through several methods: starvation, throwing off a height, drowning, devouring by animals, tearing apart by horses, dragging by horse, trampling by horses, submitting to ants, rats, snakes, immurement and dousing in lime, crucifixion, by garrotte,

hanging, decapitation, laparotomy, slicing of throat, drowning, shooting with arrows, cannon, firing squad, neck shot, burying alive, stoning, roasting, burning, impalement, pouring of boiling resin, boiling in a cauldron, burning on mild fire, breaking on a wheel.

In Germany, the execution method selection allowed either the gallows (der Galgen) or beheading with a sword (das Schwert) – the sword was reserved for the upper class.

Heresy, witchcraft, sacrileges, blasphemy, conspiracy, political delicts, high treason, revolutionary activity, dishonour of the Majesty, wandering, espionage, adultery – were the primary crimes which demanded execution in the legal standards of the previous eras. During the Napoleon wars, firing a Girandoni repeating air rifle (die Windbüchse); or similarly, for shooting from a machine gun, flamethrower (it was considered dishonourable advantage in combat), horse theft, theft, rape, sodomy, infanticide, murder and robbery. Other minor crimes, such poaching and stealing fish also elicited grounds for capital punishment (Welch 2004).

The death penalty's shame was furthered effected through draconian body mutilation – e.g., cutting off of limbs, plucking out of eyes, cutting out of tongue, burning, flaying. Ashes of the burnt were poured in a river, the hanged were left hanging at the mercy of birds, cut off heads were left stuck on pikes and mangled bodies woven onto breaking wheels. The aim was that the executioner was disgraced as much as possible; according the ecclesiastical stance of Christianity, the condemned were prohibited burial in sacred soil. Autopsy was one of the means of intensifying the punishment as well.

As the term itself shows (*ἀνατέμνειν*, ana-temnein = to cut), anatomy is connected with autopsy. Health and illness, labour and death, woman and man, human and animal, have ever been among the basal existential questions the solution of which was sought in the body composition. It is impossible to find out the *primum movens*, from culinary observations, from injuries and illnesses, animal autopsies were the source of knowledge, performed by Aristotle (384–322 B.C.) and later on a much higher level by Claudius Galenus (129–216 A.D.) (Hyrtl 1835).

Through autopsies, the anatomists were rapidly gaining a new context of knowledge – achievements otherwise limited by the previous channels of discovery though other natural sciences. There was generally an elemental aversion against autopsy of humans during which the skin is removed, like with animals (in mythology the god Apollo flayed Marsyas alive), which led to prohibition of human autopsies. Religious conceptions of possible afterlife added to the natural repulsion. Manipulation linked to preserving dead bodies did not provoke such opposition; it was everyday life in Egypt. The practice of Joseph after the death of his father, Jacob, is described in the *Book of Genesis*: “... *praecepitque servis suis medicis ut aromatibus condirent patrem quibus iussa expleant transierunt*

*quadraginta dies iste quippe mos erat cadaverum conditorum flevitque eum Aegyptus septuaginta diebus.*” (“*And Joseph commanded his servants the physicians to embalm his father: and the physicians embalmed Israel. And forty days were fulfilled for him; for so are fulfilled the days of those which are embalmed: and the Egyptians mourned for him threescore and ten days.*”) (Genesis 50: 1–4; King James Version)

Advancement in human anatomy began in Greek Alexandria, the centre of natural sciences, physics and mathematics: *Theofrastos* (372–287 B.C.), *Euclid of Alexandria* (ca. 325–ca. 260 B.C.), *Archimedes of Syracuse* (ca. 287–ca. 212 B.C.).

In Alexandria for the first time we encounter autopsies connected to executions. The anatomists *Herophilus of Chalcedon* (335–280 B.C.) and *Erasistratus of Cios* (304–250 B.C.) made many discoveries in human anatomy. Herophilus was the first person to dissect dead bodies, but he also performed vivisections on criminals. He was the first person to define the difference between the brain and the cerebellum and described seven of the cranial nerves, thalamus scriptorius (transition of the fourth ventricle into the spinal canal). He performed a detailed autopsy of the eye and described the retina and the optic nerve. He described the difference between veins and nerves, further differentiating between motor and sensory nerves. He discovered that limbs are controlled by nerves. He considered brain the seat of reason, the heart the seat of feelings. The *torcular Herophili* (confluence of sinuses) is named after him (von Staden 1992; Acar *et al.* 2005; Wiltse 1998). Historical evidence of the anatomic work of the Alexandrian school burned in 47 B.C. during Caesar's Civil War, the accounts are taken from citations in Galen and Oribasius (320–403).

Ca. 200 years later, *Aulus Cornelius Celsus* (ca. 25 B.C. – ca. 50 A.D.) writes in his tract *De medicina, Liber I, Prooemium*:

“*Ergo necessarium esse incidere corpora mortuorum, eorumque viscera atque intestina scrutari; longeque optime fecisse Herophilum et Erasistratum, qui nocentes homines a regibus ex carcere acceptos vivos inciderint, considerarintque etiamnum spiritu remanente ea, quae natura ante clausisset, eorumque positum, colorem, figuram, magnitudinem, ordinem, duritiam, mollietiam, levorem, contactum, processus deinde singulorum et recessus, et sive quid inseritur alteri, sive quid partem alterius in se recipit: neque esse crudele, sicut plerique proponunt, hominum nocentium et horum quoque paucorum suppliciiis remedia populis innocentibus saeculorum omnium quaeri.*” (“*Hence it becomes necessary to lay open the bodies of the dead and to scrutinize their viscera and intestines. They hold that Herophilus and Erasistratus did this in the best way by far, when they laid open men whilst alive – criminals received out of prison from the kings – and whilst these were still breathing, observed parts which beforehand nature had concealed, their position, colour, shape, size, arrangement,*

hardness, softness, smoothness, relation, processes and depressions of each, and whether any part is inserted into or is received into another. For when pain occurs internally, neither is it possible for one to learn what hurts the patient, unless he has acquainted himself with the position of each organ or intestine; nor can a diseased portion of the body be treated by one who does not know what that portion is. When a man's viscera are exposed in a wound, he who is ignorant of the colour of a part in health may be unable to recognize which part is intact, and which part damaged; thus he cannot even relieve the damaged part. External remedies too can be applied more aptly by one acquainted with the position, shape and size of the internal organs, and like reasonings hold good in all the instances mentioned above. Nor is it, as most people say, cruel that in the execution of criminals, and but a few of them, we should seek remedies for innocent people of all future ages." (Celsus–Spencer 1935; Sands 1914).

Two more centuries later, in his tract *De Anima*, cap 10, *De Simplicitate Svstantiae quod et spiritus ipsa sit* (On the Soul, Chap. 10) the Church Father **Quintus Septimius Florens Tertullianus** (anglicised as **Tertullian**) living in Carthage (160–230 A.D.), heatedly attacks Herophilus for vivisectioning six hundred prisoners.

"Herophilus ille medicus aut lanius, qui sexcentos exsecuit, ut naturam scrutaretur, qui hominem odit, ut nosset, nescio an omnia interna eius liquido explorarit, ipsa morte mutante quae uixerant, et morte non simplici, sed ipsa inter artificia exsectionis errante." ("There is that Herophilus, the well-known surgeon, or (as I may almost call him) butcher, who cut up no end of persons, in order to investigate the secrets of nature, who ruthlessly handled human creatures to discover (their form and make): I have my doubts whether he succeeded in clearly exploring all the internal parts of their structure, since death itself changes and disturbs the natural functions of life, especially when the death is not a natural one, but such as must cause irregularity and error amidst the very processes of dissection.") (Transl. Holmes 1870, Waszink 1954).

This heated statement is no proof that said practices were widely allowed or accepted. However, in Ancient Alexandria, death, perhaps even a gruesome death, was a natural part of everyday life.

Reaching the oft-debated prohibition of autopsies, Pope Boniface VIII's bull from 1300 *De sepulturis* (Concerning Burials) states:

"Corpora defunctorum exenternantes, et ea immaniter decoquentes, ut ossa a carnibus separata ferant sepe-lienda in terram suam, ipso facto sunt excommunicati." ("Persons cutting up the bodies of the dead, barbarously cooking them, in order that the bones, being separated from the flesh, may be carried for burial into their own countries, are by the very fact excommunicated.")

"Detestandae feritatis abusum, quem ex quodam more (Alias, \_modo\_) horribili nonnulli fideles improvide prosequuntur, nos pia intentionis ducti proposito,

ne abusus praedicti saevitia ulterius corpora humana dilaceret, mentesque fidelium horrore commoveat, et perturbet auditum, digue decrevimus abolendum." ("As there exists a certain abuse, which is characterized by the most abominable savagery, but which nevertheless some of the faithful have stupidly adopted. We, prompted by motives of humanity, have decreed that all further mangling of the human body, the very mention of which fills the soul with horror, should be henceforth abolished.").

Historical consultation of the original document has shown that it does not refer even distantly to the practise of dissection for teaching purposes but was a warning against the prevalent habit of dismemberment and bowling of the bodies of dead Crusaders for transportation and burials in their own lands (Walsh 1908).

Considering both the text as a whole and contextual meaning of the words used, it is clear that the topic of this text is not autopsy. Not once is used one of the Latin words used to describe autopsy: *obductio* or *sectio anatomica*. The verb used here, *exentrare*, which is borrowed from Greek, is translated in medieval codices as "to eviscerate".

This reference to these documents is interesting also, because it allows of cremation, a topic of many theological disputes:

"... sepulturae tradantur ad tempus, ita, quod demum incineratis corporibus, aut alias ad loca, ubi sepulturam elegerint, deportentur, et sepeliantur in eis." ("... let them be given sepulture for the time either in the city or the camp or in the place where they have died, or in some neighbouring place, so that, when finally their bodies have been reduced to ashes or otherwise, they may be brought to the place where they wish to be buried and there be interred.").

Of course, there were clerics outpopping the Pope, so to speak. There is evidence that almost all notable Italian anatomists were also the Popes' personal physicians, superior in extent of their education (Marini 1784).

Anatomy needed a stable supply of dead bodies. Suicides, those left without kin, alms-house inmates, single mothers, illegitimate children, the handicapped, volunteers, those who died without kindred in hospitals like *Ordo Hospitalarius Sancti Ioannis de Deo* (Order of Brothers Hospitallers of St. John of God) augmented their cadaver supply. Public pressure resulted in the above-mentioned victims' burial in holy soil. However, a secure source was found in condemned prisoners, since public autopsy was understood as an intensification of the capital punishment. Although recognized by the courts, public display (specifically the bodies of the hanged and those woven onto wheels as a warning to the public) was preferred over autopsy. However, the anatomists required the execution method employed would preserve the condemned's remain intact for feasible autopsies (Stukenbrock 2001).

Thusly, königlichen Statthaltereii (decrees of the royal governorship) from the 9<sup>th</sup> of January 1631 orders the mayor of Prague's New Town to hand over convicts

after the execution by strangulation exclusively to anatomical studies.

“... aus den zum Tode verurtheilten Verbrechen ... ein Weib oder einen Mann durch den Scharfrichter erdrosseln und dann ad studium anatomicum den Doctoren und Chirurgen übergeben zu lassen.” (“Criminals under sentence of death ... A female or a male after strangulation by the executioner to be left to physicians and surgeons for studies.” (Hyrtl 1841).

It needs to be emphasized that it was the execution by strangulation, not hanging by the neck, because hanging by the neck causes an excessive hyperlordosis of the spine. Braune demonstrates this phenomenon on a frozen body of a suicidal pregnant woman, whose spine is unnaturally bent (Braune 1872).

Interesting is the activity of **Andreas Vesalius** (1514–1564), who writes in *Epistola ad Ioachimum Roelants – Epistola rationem modumque propinandi radicis Chynae decocti* (*The China Root Epistle*): “Saepius iudicibus molestus eram, ut hoc vel illo supplicio homines necarent, sive in hoc vel illud tempus sectionibus opportunum vivos servent.” (“I will no longer be a nuisance to judges to have people killed with one form of execution or another or reserve them for this or that opportune time for our dissections.”) which proves that criminals were yielded to anatomists and physicians for various experiments (Transl. Garisson 2015; Brucknerová, Holomáňová 2013).

In terms of the Vesalius case, there was a notable incident in 1559. The French king Henry II (1519–1559) was fatally wounded in a jousting match by the captain of his Scots Guards, Gabriel de Lorges, comte de Montgomery. De Lorges thrust a spear into the king’s left eye and the spearhead entered his brain. He was treated by the royal surgeon **Ambroise Paré** (1510–1590), who however failed to save him. The king died and a detailed autopsy was performed. Heads of executed criminals (their number varies) were provided and reconstructions of injury of the eye socket were performed. “It is also possible that the King had an associated subdural hematoma as suggested by the aforementioned authors; one could also add to the differential diagnosis the possibility of a subdural empyema because this process would have explained the fever, meningismus, herniplegia, and seizures and could still be reconciled with the autopsy findings.” (Majr 1992).

Obtaining criminals’ cadaver after a suitable for a quick execution and experiments at that time posed little problems in terms of supply (Norwich 1991).

We read of the abuse of those under sentence of death in **Gabriele Falloppio’s** (1523–1562) *Libelli duo alter de ulceribus: alter de tumoribus praeter naturam*:

“Febris multum resistit veneno frigido, quod ego expertus sum Pisis in homine anatomizando. Nam princeps jubet, ut nobis dent hominem, quem nostro modo interficimus et illum anatomizamos, cui exhibui drachmas duas opii et adveniens paroxysmus, nam hic patiebatur quartana, prohibuit opii actionem. Hic gloriabundus

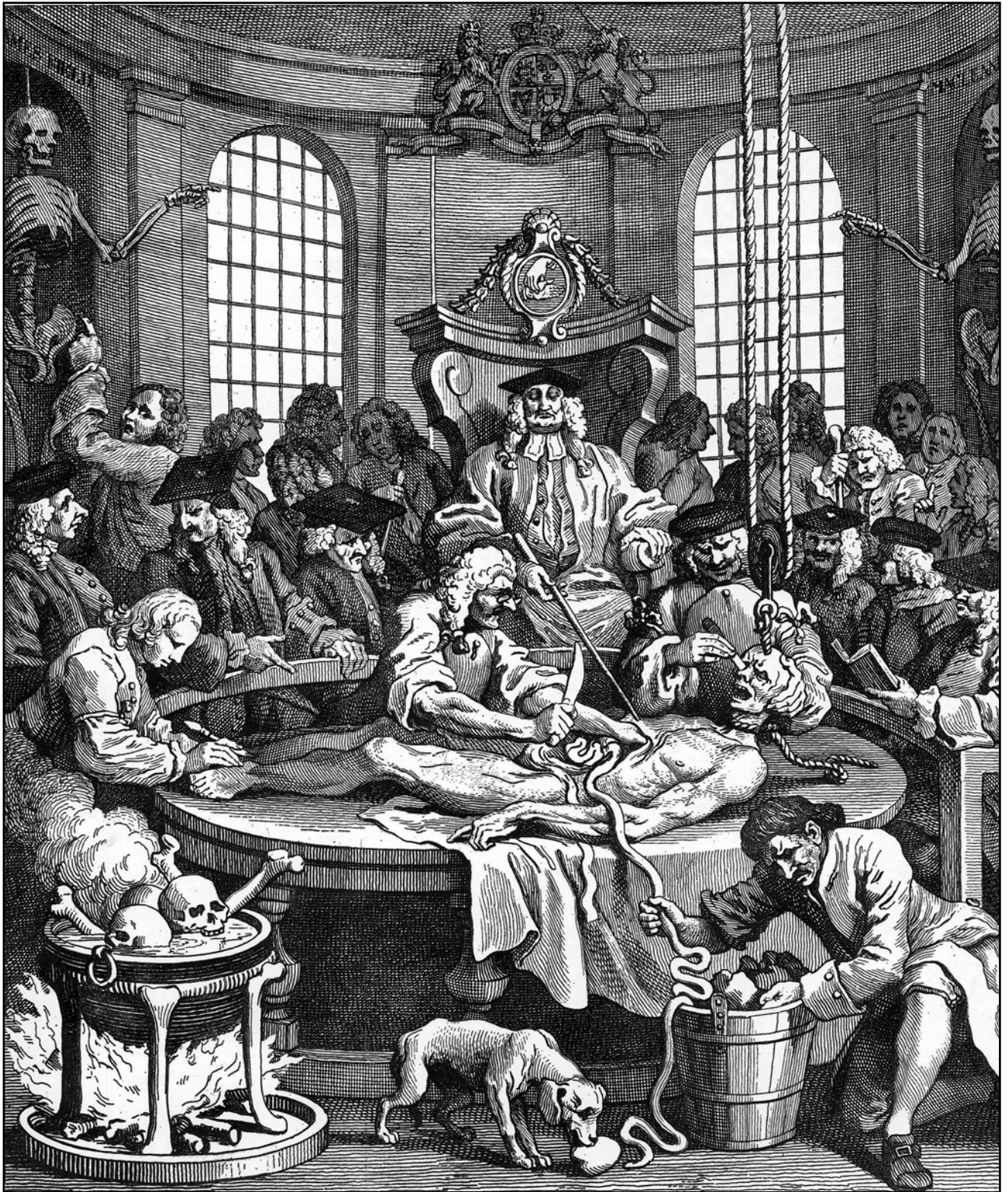
rogavit, ut bis adhuc exhiberemus, quodsi non merreretur, ut procurarem pro ejus salute apud principem. Rursus illi exhibuimus extra praxysmum drachmas duas opii, et motuus est ... Dicam, quod accessit, cum essem Pisis. Dux enim corpora justitiae tradenda anatomicis exhibuit, ut morte, quae sibi videbatur, ab ipsis interficerentur. Nos autem exhibuimus drachmam opii et spatio septem horarum ipsum interfecimus. ... Medici Pisani homines supplicio destinatos a iudicibus impetrarunt in usum dissectionis, quibus opii binas tresve drachmas ex vino meracissimo exhibebant, ne ullos humores dissipari contingat, aut crassiores spiritus evanescere.” (“Fever resists the cold poison a lot, which I have found in Pisa in an autopsy of a man. For the Duke ordered that we were given a man for us to kill in our way and perform an autopsy. I gave him two drachms of opium, and the oncoming seizure (he was suffering from four day fever) inhibited the effect of opium. The man rejoiced and beseeched us to give him twice more, and if he didn’t die to persuade the Duke to spare him. Again we gave him two drachms of opium outside the seizure and he died. ... I’m saying what happened when I was in Pisa. The Duke would give bodies that were to be brought to justice to anatomists, to kill them in a way they preferred. We then administered two drachms of opium and killed them within seven hours. ... Judges in Pisa would give people under sentence of death to physicians to use them for autopsies. They would give them two to three drachms of opium from the purest wine, in order to prevent any bodily fluid loss or evanescence of thicker spirits.” (Spirits (pneumata): According to anatomical knowledge of the time, blood received pneumata in the lungs, i. e. breath, air.) (Fallopius 1563; von Murr 1805; Hyrtl 1841).

The convict received a high, lethal dosage of opium, and thus relieved of suffering of the torture. While this method could be viewed as a form of euthanasia, it remains debatable, as anatomists were not driven by an effort to reduce their suffering, but by an effort to get an intact specimen. From the standpoint of medical ethics, it is inexcusably inhumane.

**Gaius Plinius Secundus** (anglicised as **Pliny the Elder**, 23–79 A.D.) in *Historiae naturalis libri XXXVII* writes: “Discunt (medici) periculis nostris et experimenta per mortes agunt, medicoque tantum hominem occidisse impunitas summa est.” (“Physicians acquire their knowledge from our dangers, making experiments at the cost of our lives. Only a physician can commit homicide with complete impunity.”) (Plinius 1830)

Joseph Hyrtl in his *Antiquitates anatomicae rariores, quibus origo, incrementa et status anatomes, apud antiquissimae memoriae gentes, historica fide illustrantur, v Caput secundum – Incrementa anatomes, § 17 Victimae humanae* indicates cases of abuse of convicts. “Vivos homines in experimenta medica adhibitos fuisse, omnibus comperta res est!” (“It is known to everyone that living people were handed over for medical experiments.”)

On page 34: “Ludovicus XI., Christianissimus Galliae rex, chirurgis Parisinis permisit, ut milites inter



**Figure 1.** William Hogarth: The four stages of cruelty – The reward of cruelty (Plate IV).

*arma captos, ad experimenta chirurgica vivos habeant, et calculi vesicae extrahendi modum varium tentarent.* (“Louis XI, though a Christian king of France, allowed for war prisoners to be handed over to surgeons, who were supposed to learn even extraction of urinary stones on them.”).

Such activities are in direct violation of medical ethics; anatomists and physicians were cogs in the cruelty machinery of the time. The Church solved the discrepancy between the Decalogue and torture was solved by handing heretics over to secular power, which could do anything with them. No proof has been found

that the Church refused torture during the Inquisition hearings and to intensify the capital punishment; only the Enlightenment brought that.

**Giovanni Filippo Ingrassia (Ioannis Philippi Ingrassiae)** (1510–1580), student of Vesalius, was called the *Sicilian Hippocrates*. Known as the founder of legal medicine. In 1578 he wrote *Methodus dandi relationes pro mutilatis torquendis aut a tortura excusandi, pro deformibus, venenalisque judicandis; pro elephantiacis, extra urbem propulsandis, sive intus urbem sequestrandis, vel fortassis publice conservari dimittendis*. (*The method of setting rules for easement or skipping torture, for the mutilated, regarded infectious, affected by elephantiasis, whether it is necessary to drive them out of the city, or to keep them isolated in the city, or perhaps to save them at the expense of the community for discharge. An evaluation, from an anatomical standpoint, of the contemporary methods of torture employed by the Roman Inquisition.*) (Ingrassia 1578 & 1637).

Even in 866, Pope Nicholas I rejected torture as a crime against the law of both men and God. Nonetheless, he provides a contrast, in 1252 in his bull *Ad extirpanda* (“To root up”, named after the opening words) in which Innocent IV authorizes inquisitional tribunals for use of torture.

Caricature *The Reward of Cruelty – Four Stages of Cruelty* (Picture Autopsy of the villain Tom Nero) by William Hogarth (1697–1764) is not meant to ridicule the anatomists; the autopsy in his concept makes up the peak of the punishment, revenge for crimes on people and animals, and is considered God’s Revenge against Murder (Hogarth 1751; Warren 2010).

In 1621 in Prague, after the mass execution of twenty-one convicts, twelve of the cut off heads were displayed on the Old Town Bridge Tower. Among the beheaded, there was also the rector of the Charles University, the anatomist **Jan Jessenius** (1566–1621). Jessenius, Hieronymus Fabricius’ student, was the first to perform a public autopsy, contributing greatly to the development of anatomy. In his tract *Pro anatome sua actio et ad spectandum indicatio* he clarified the importance of autopsies from the standpoint of anatomical knowledge against ecclesiastic opponents. The autopsy of an executed man took place in Rečák College in June 1600; it took five days and about 5,000 people attended as spectators (Jessenii 1601). He published the description of the autopsy in his *Anatomiae Pragae anno MDC solenniter administrate historia* in Wittenberg. Jessenius is quoted by Thomas Bartholini (1615–1618) and Antoine Portal (1742–1832). In his anatomical paper one section expounded on the tongue and speech formation; as the ideologist of the uprising, his tongue was cut out before his decapitation. The verdict read: “... dass ihm zuerst die Zunge abgeschnitten und der Kopf abgeschlage, der Leichnam unter dem Galgen gevierteilt, und die Stücke an den Strassen auf Pfähle gespießt werden sollten.” (“... that his tongue should be cut out and his head cut off, the corpse beneath the gallows quartered and the pieces

impaled on stakes in the streets.”) (Pelcl 1774; Denis 1890, 1903).

Apparent death (*mors putativa, vita minima, vita reducta*) has accompanied medicine for centuries; it is not interchangeable with *thanatomimesis*, known in zoology. There are tales of people coming back to life before burial, after burial, or even during autopsy. In connection with anatomists, there is a documented case from 1650 (Hughes 1982).

Anna Green, born in 1628, gave birth to a stillborn illegitimate child, but she was accused of infanticide of a bastard and on the 14<sup>th</sup> of December 1650, after a confession of which she claimed her innocent, she was hanged on the courtyard of Oxford. “Thirty minutes passed, during which time her friends ‘thumped her on the breast’ and hung ‘with all their weight upon her leggs [sic]... lifting her up and then pulling her downe againe with a suddain [sic] jerke’ in order to quicken her death. She was then executed in the customary way by being turned off the leddert to hang by the neck. Receiving many grat and heavy blowes on the brests by the but end of the Soldiers Muskets, shi hung for half an hour during wich time one of her fiends thumped her on the breast, other hanging with all their weight upon her legs, sometimes lifting her up, and then pulling her down again with a sudden jerk, thereby the sooner to despatch her of her pain.

Eventually, Anne’s body was cut down from the gallows and placed in a coffin. A day later when anatomist Thomas Willis (1621–1675) and scientist William Petty (1623–1687) were about to make an incision which would split the body open from the sternum to the pubic bone, the students found out that Greene had a faint pulse and was weakly breathing. Willis and Petty quickly came to her aid. She was revived by having hot cordial poured down her throat, having her limbs and extremities rubbed, being bled, having heating plasters applied and having a ‘heating odoriferous Clyster’ to be cast up in her body, to give heat and warmth to her bowels. After being placed in a warm bed with another woman, to keep her warm, she recovered fully. Within twelve hours, Anne was able to speak; within a day, she could answer questions. Her first words were: ‘Behold goods providence.’

Given her miraculous resuscitation, Anne was granted a reprieve and declared innocent, the assumption being that the baby had been born stillborn. She later married and bore three more children. Though one must wonder how she slept at night...” (cited by Watkins 1651).

The examples of death certification false positive (*vita minima*, Lazarus phenomenon) enabled in the 18th century the exact determination of death. The knowledge of pathological anatomy and biomechanics are indispensable in modern forensic sciences (Adamec & Jelen 2010).

Nine years later, inspired by the above mentioned story, physicians began with vivisection experiments. In 1658, **sir Christopher Michael Wren** (1632–1723) inserted wine and opium in a dog’s infusion, and the

dog survived. He had used a hollowed-out goose quill as a catheter, and a pig's urinary bladder as a container. "I injected wine and ale in to the mass of blood in a living dog by a vein in good quantity, till I made him drunk but soon after he pissed it out..." (Martensen 2004; Bozzetti et al. 2014).

This was followed by the first transfusions of blood, performed by **Richard Lower** (1631–1691) in 1665 between animals, and then from a sheep to a mentally ill patient (who survived due to a small dosage) (Lower & King 1667; Greenwalt 1997, Stansbury & Hess 2010).

Changes came in the 18<sup>th</sup> century, thanks to the Enlightenment. In France, the embodiment of Enlightenment endeavours, *Encyclopedie, ou Dictionnaire raisonné des sciences, des arts et des métiers* (Denis Diderot, Jean Le Rond d'Alembert), began to be published in 1751, but atrocities continued. Robert-François Damiens (1715–1756) declared himself an instrument of God, wanted to save King Louis XV (1710–1774) from departure from the true faith and in 1757 he stabbed him several times with a knife. He was tried for an unsuccessful assassination of the King.

"On 1 March 1757 Damiens the regicide was condemned to make the amende honorable before the main door of the Church of Paris, where he was to be taken and conveyed in a cart, wearing nothing but a shirt, holding a torch of burning wax weighing two pounds; then, in the said cart, to the Place de Grève, where, on a scaffold that will be erected there, the flesh will be torn from his breasts, arms, thighs and calves with red-hot pincers, his right hand, holding the knife with which he committed the said parricide, burnt with sulphur, and, on those places where the flesh will be torn away, poured molten lead, boiling oil, burning resin, wax and sulphur melted together and then his body drawn and quartered by four horses and his limbs and body consumed by fire, reduced to ashes and his ashes thrown to the winds." (*Pièces originales...*, 372–4).

"Finally, he was quartered, recounts the *Gazette d'Amsterdam* of 1 April 1757. This last operation was very long, because the horses used were not accustomed to drawing; consequently, instead of four, six were needed; and when that did not suffice, they were forced, in order to cut off the wretch's thighs, to sever the sinews and hack at the joints..." (cited from Foucault, transl. A. Sheridan 1995).

The execution was conducted by **Charles-Henri Sanson de Longval** (1739–1806), a French executioner who, especially during the French Revolution, performed up to three thousand executions (Louis XVI, Charlotte Corday, Georges Danton or Maximilien Robespierre).

Such atrocities aroused protests; in the beginning of the French Revolution an abandonment of the capital punishment was being discussed. After debates on how to end culprits' lives without torture and pain, a tool was chosen, on whose implementation participated the physician **Joseph Ignace Guillotin** (1738–1814) and the

surgeon and physiologist **Antoine Louis** (1723–1792), who designed the prototype (temporarily called "*la Louissette*"). His name is associated with the characterization of the sternal angle (*angulus sterni*, "angle of Louis"), though there are more candidates for the invention, including Daniel Ludwig (1625–1680) (Coscione et al. 2013; Derrida 2014).

Same death was ordered for all citizens without exception. Bodies of the executed were handed over for funerals, by the Roman law (*the crime ends with death, crimen morte finitur*) (Buklijas 2008).

Not only the mob and inquisitives watched the mass executions. Present were usually the friends, family, and scientists, who were interested if – or how – the severed head reacts. Among convicts there were also people devoted to natural sciences, who promised cooperation after the execution. Among them was the famous chemist **Antoine-Laurent de Lavoisier** (1743–1794). However, accounts of his head's blinking are probably hoax, since at the time of his execution there was no time for experiments due to a high number of convicts. It was submitted that reflectorical blinking of the decapitated occurs for five to six seconds (Beaurieux 2009).

The question of subjective feeling of pain during decapitation is insolvable. The all-round educated anatomist Samuel Thomas von Sömmering (1755–1830) questioned painlessness of the guillotine, physiologists dealt with the relation between irritability and sensitivity (von Sömmering 1784). The evaluation was certainly affected by political aspects between supporters and opponents of the Revolution. The debate is thoroughly analysed by Chamayou (Chamayou 2008; Von Sömmerring 1784).

Surprisingly, even the physiologist **Pierre Jean George Cabanis** (1757–1808) stood up against the guillotine. Cabanis was trying to explain all psychological phenomena based on biological processes; all psychological processes take place based on sensation and neural activity, thinking is a product of the brain, not soul. His pivotal work is *Rapports du physique et du moral de l'homme* (*On the relations between the physical and moral aspects of man*, 1802). It is a collection of essays from 1796–1797, among which there was the tract on the guillotine *Note sur le supplice de la guillotine*. "Strangely enough, he advocated the scaffold against Soemmering and Süe on an argued physiological ground, while he strongly condemns it from a political and moral standpoint. This ambivalence could be explained by the paradoxes of the culpability felt by the humanist practitioner who had to represent the Paris Hospitals Commission when the machine to be the Great Terror's servant was tested, for the first time, by Louis, Guillotine and Pinel." (Cabanis 1796; Chazaud 1998).

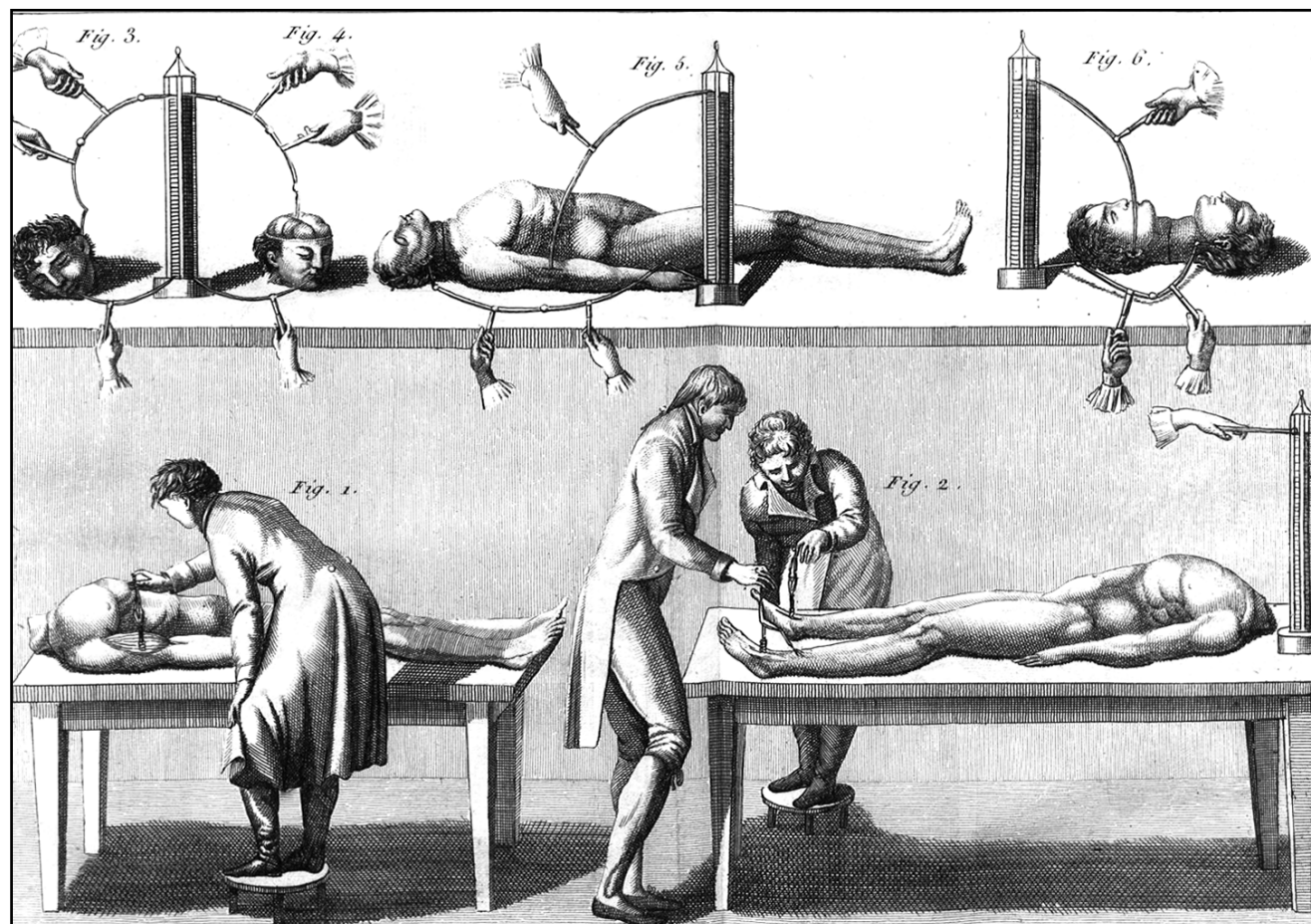
In the end, the guillotine was not generally considered a humane procedure in lessening the condemned's suffering during execution. The number of guillotined during the French Revolution is estimated at 17,000. Its frequent use rendered the guillotine as

an iconic symbol of revolutionary terror. By contrast, more than 2,500,000 soldiers fell during the Napoleon wars, which does not provoke such strong emotions; yet memorials are built to honour the Emperor, and not the anatomists.

The guillotined murderess who stabbed with knife Jean Paul Marat (1743–1793) Charlotte Corday (1768–1793), “testified at trial that she had carried out the assassination alone, saying “I killed one man to save 100,000.” It was likely a reference to Maximilien Robespierre’s words before the execution of King Louis XVI. Four days after Marat was killed, on July 17, 1793, Corday was executed under the guillotine. Immediately upon decapitation, one of the executioner’s assistants – a man hired for the day named Legros – lifted her head from the basket and slapped it on the cheek. Witnesses report an expression of unequivocal indignation “on her face when her cheek was slapped. This slap was considered an unacceptable breach of guillotine etiquette, and Legros was imprisoned for 3 months because of his outburst.” (Cited Murderpedia). Even scholars addressed whether the head blushed from shame, grief or indignation; blood loss does not allow such reaction. Marat’s autopsy proved injury of the lungs, aorta and left ventricular; the heart was stored separately. Cor-

day’s autopsy proved that she was *virgo intacta* (before the execution there were rumours of her pregnancy).

The Italian physician and scholar **Giovanni Aldini** (1762–1834), *Luigi Galvani’s* (1737–1798) nephew, professor of physics in Bologna, dealt with galvanism in anatomical and physiological research, which he described in his publication *Essai théorique et expérimental sur le galvanisme* (Aldini 1804). He experimented on isolated heads of poikilotherms, cattle and dogs. After the execution, he would irritate the guillotined criminal with electric current from Volt batteries in the areas of *corpus callosum* (callosal commissure), ears, he caused convulsions of the facial muscles; irritating the optical nerve had no effect on eyelid movement. On the decapitated body, he monitored its temperature; he irritated the biceps, extensors and quadriceps. Irritating the spinal cord and the diaphragm caused contractions in the entire abdominal area. He monitored muscle movement up to an hour and a half after the execution. He cooperated with the anatomist Mondini, who dissected the *cortex*, *corpus callosum*, *corpus striatum* (neostriatum or striate nucleus), optical nerve and the cerebellum. By irritating the pectoral and intercostal muscles he imitated breathing in an experiment. He also performed experiments on the heart.



**Picture 2.** Experiments with cadavers and severed heads. (*Essai théorique et expérimental sur le galvanisme*, tome premier – Theoretical and Practical Essay on Galvanism, first volume), 1804.



Aldini's experiment in London in 1803 became quite famous. During it, he stimulated muscles of a hanged man with galvanic electricity – battery. The convict was a double murderer *George Foster*. “He died very easy; and, after hanging the usual time, his body was cut down and conveyed to a house not far distant, where it was subjected to the galvanic process by professor Aldini, under the inspection of Mr Keate, Mr Carpue and several other professional gentlemen. On the first application of the process to the face, the jaws of the deceased criminal began to quiver, and the adjoining muscles were horribly contorted, and one eye was actually opened. In the subsequent part of the process the right hand was raised and clenched, and the legs and thighs were set in motion. Mr Pass, the beadle of the Surgeons' Company, who was officially present during this experiment, was so alarmed that he died of fright soon after his return home.” (Cited by The Newgate Calendar).

Aldini claimed that his experiments and research were motivated primarily by an effort to find a way to “induce back a life dimmed”; he considered using the knowledge on lunatics (“dans la folie”) and against apoplexy (MacDonald 2006).

Galvanism and Aldini's experiments were probably known to the English writer and inventor of the sci-fi genre of literature, *Mary Shelley* (1797–1851), when in 1818 she created the immortal characters of a cold-blooded, murdering monster – birthed from a resurrected corpse formed numerous components of cadavers, and his creator, the infamous Doctor Frankenstein.

Experiments with electrical stimulation of the central nervous system (CNS) which Aldini conducted on decapitated animals and executed humans have persisted, albeit in a sophisticated form, up to this day (Rusina *et al.* 2005).

In the Nazi regime, there is evidence of repeated exploitation of political prisoners, prisoners of war and deported Jews, which often resulted in death. An increasing number of executed in German prisons and an increase of anatomical collections is documented (Becker 1987; Stuken 2000).

Quite disturbing also is the evidence of detailed anatomical work from the beginning of World War II *Topographische Anatomie des Menschen*. Her author was Professor **Eduard Pernkopf** (1888–1955), Viennese anatomist, an active member of Nationalsozialistische Deutsche Arbeiterpartei (National Socialist German Worker's Party). Pernkopf was imprisoned by the Allies in 1945. In 1948, he was released and stripped of all his academic degrees. For the rest of his life he painstakingly worked on topographic anatomy. He died suddenly of a stroke on April 17, 1955. The Anatomy was finished by *Werner Platzer*.

The Nazi origin of the texts has always been obvious. Pernkopf cooperated with four artists – *Erich Lepier, Ludwig Schrott, Karl Endtresser and Franz Batke* – all of whom were also members of the National Social-

ist German Worker's Party. In earlier publications, the authors even embedded swastikas and SS symbols in their signatures. However, this evidence of proof was largely ignored by the medicine community for a long time, until *Howard Israel* and *William Seidelman* published a text in JAMA questioning the origin of Pernkopf's specimens, articulating the theory that the depicted could have been victims of the Nazi terror (Israel & Seidelman 1996, Williams 1989). The excellent painter *Erich Lepier* signed his paintings with a *Hakenkreuzs* (swastika). During the war many cadavers used by the Anatomy Institute were those of people executed in the *Wiener Landesgericht* (the Vienna district court). After his release from internation, Pernkopf continued with his work on topographic anatomy. “Lepier continued his significant career in scientific illustration after Pernkopf died by preparing beautiful color illustrations for the Sobotta/Becher *Atlas der descriptiven Anatomie des Menschen*. Judged by any standard, Pernkopf's *Topographische Anatomie des Menschen* is a remarkable feat. „Nazi science and art of merit, regardless of its contribution to mankind, can be difficult to fully appreciate in light of the incredible cruelties the regime inflicted on Jews and others it considered its enemies. For this reason Pernkopf's *Topographische Anatomie des Menschen* will always be controversial and will, unfortunately, never be acknowledged by some as the masterpiece it truly is. For others it will remain the greatest work yet done in anatomic illustration.” (Cited by Williams 1989).

## CONCLUSION

The aim of this article was not to serve as a moral criticism. The authors have no intention in judging individual deeds, behaviour of people – scientists notwithstanding. The aim was to describe the toilsome path towards knowledge on the background of – often cruel – historical circumstances. Thus, we arrive at the conclusion that efforts to discover the structure of the human body also established the knowledge of physiology. Science of the human body did not develop in isolation; anatomists tried to use knowledge of physical and chemical sciences of their time during their research. Thanks to their detailed, painstaking and exact documentation of their work's results, they laid the foundation for forensic sciences, especially forensic anatomy and forensic medicine – medical jurisprudence.

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