That Most Noble Art: A Critical Analysis of Surgical Practices in the High Roman Empire

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"Enea ferito". Pompeiian fresco, Casa di Sirico (VII, 1, 25.47).
Conserved at Museo Archeologico Nazionale di Napoli (inv. nr. 9009)

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Chapter I: Development of Surgery as Medical Practice in the Mediterranean

To understand the state of surgery in the second century CE, which I am considering to be the height of not only empire, but also of Roman surgical developments, it is necessary to recount the major developments in medicine that led to that point. No one knows precisely when medical practice begins, but we are certain that a rudimentary form of basic medical care was already being administered in prehistoric times. This early medicine was based around the use of plants and clays as the primary methods of treatment.[1] Women were most likely the primary collectors of these materials during this time, as many would have practiced simple forms of herbalism for their immediate families.[2] As to how humans began to develop these practices, we are unsure. Evidence exists, however, that the development of basic herbalism was not limited solely to *Homo sapiens* – indeed, other primate species have been documented practicing self-medication with plant matter.[3] Maybe early humans learned basic herbalism through trial and error, and this knowledge was passed down orally through the generations; however, we are still unsure. Geophagia, the ingestion of soils or clays, has been well documented among not just wild and domesticated animals[4], but also early humans.[5] Therefore, early humans may have developed medicine not through trial-and-error alone, but in conjunction with observing and learning from the behaviors of the animals around them.

Medicine was inseparable from magic and religion, from prehistory through the end of antiquity. The belief in spirits that resided in both animate and inanimate objects that could cause good or ill to humans was very often a hallmark of early societies, even up until the end of antiquity;

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[1] Sigerist, Henry E. *A History of Medicine*. Vol. 1. New York: Oxford Univ. Press, 1951. 108.
[2] Ibid.
[3] Fruth, B., *et al.*, "New Evidence for Self-medication in Bonobos: Manniophyton Fulvum Leaf- and Stemstrip-swallowing from LuiKotale, Salonga National Park, DR Congo." *American Journal of Primatology* 76, no. 2 (September 30, 2013): 146-58.
[4] Krishnamani, R., and William C. Mahaney. "Geophagy among Primates: Adaptive Significance and Ecological Consequences." *Animal Behaviour* 59, no. 5 (2000): 899-915.
[5] Abrahams, Peter W. "Geophagy and the Involuntary Ingestion of Soil." *Essentials of Medical Geology*, 2012, 433-54.

and a healthy amount of superstition was always present. As societies began to develop, and, as people began to specialize during the beginnings of the Mediterranean Bronze Age, developed villages would usually have a "medicine man" that was responsible for maintaining the health of the community.[6] They would be responsible for gathering and distributing herbs, providing medical advice, and administering supernatural treatments such as charms and spells to ward off malignant spirits.[7] As we will see, even up until the time of the ancient Romans, the practice of medicine retains a heavy supernatural component stemming from these early practices and beliefs.

When one considers the advancement from basic herbalism to surgery, one cannot help but think that this shift must have been one of the most significant early advances of ancient medicine. Most likely spurred by the development of more advanced tools, and later, bronze metallurgy, humans began to realize that specific physical manipulations of bodily structures could actually prevent or cure an ailment. Therefore, it follows that the words "surgery" and "surgeon" come from the Greek χειρουργική, *cheirourgike* (composed of χείρ, "hand", and ἔργον, "work"), and via the Latin: *chirurgiae*, meaning "hand work."[8]

The oldest surgical procedure known to us is that of trepanation[9], from the Greek τρύπανον, *trypanon,* meaning "borer." In trepanation, a hand drill is used to create a hole into the human skull, exposing the *dura mater* beneath. This procedure was utilized to relieve health problems related to intracranial trauma and diseases by relieving pressure within the skull. Evidence of trepanation precedes our earliest organized civilizations, dating back to Neolithic times.[10] In prehistory,

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[6] Ackerknecht, Erwin H. "Primitive Medicine." In *A Short History of Medicine*. Revised Edition ed. Baltimore: Johns Hopkins University Press, 1982. 10-19.
[7] Ibid.
[8] Klein, Dr. Ernest. *A Comprehensive Etymological Dictionary of the English Language*. Amsterdam: Elsevier Scientific Publishing Co., 1971.
[9] Capasso, Luigi. *Principi di storia della patologia umana: corso di storia della medicina per gli studenti della Facoltà di medicina e chirurgia e della Facoltà di scienze infermieristiche*. Rome: SEU, 2002.
[10] Ibid.

trepanation was most likely carried out with the belief that it released evil spirits that were trapped inside the body, which were the supposed causes of phenomena such as epileptic seizures, migranes, and mental disorders.[11] It also served as primitive emergency surgery after head wounds to remove shattered fragments of skull and to drain the resulting hematoma; these injuries were typical for primitive weapons such as war clubs and slings.[12] The survival rate was estimated to be rather high, considering the lack of proper sterilization techniques; by the sixth century CE, trepanation was a commonplace procedure with a high rate of success and a low rate of infection.[13]

The earliest significant advances in medicine by a Mediterranean society took place in Ancient Egypt.[14] Egyptian medicine was groundbreaking, to say the least, and the developments they made would serve as the basis for Greek and, later, Roman medicine. One groundbreaking development was the creation of metal surgical tools. Humans began to work with copper and bronze sometime after 4000 BCE, and though dates are indefinite for the creation of certain tools, the first copper tweezers thought to have been used for surgery are estimated to be from 3300 BCE.[15] The metal probe, needle, and knife almost certainly preceded the creation of the tweezers, but we lack the evidence to assign a specific date to their creation.[16] What we do know, however, is that the invention of metal surgical tools allowed for a greater variety of surgical procedures to be performed.

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[11] Brothwell, Don R. *Digging up Bones; the Excavation, Treatment and Study of Human Skeletal Remains*. London: British Museum (Natural History): 1963. 126.
[12] Weber, J.; A. Czarnetzki. "Trepanationen im frühen Mittelalter im Südwesten von Deutschland – Indikationen, Komplikationen und Outcome". *Zentralblatt für Neurochirurgie* (in German). 2001. **62** (1): 10.
[13] Ibid.
[14] Allen, James P., and David T. Mininberg, M.D. *The Art of Medicine in Ancient Egypt*. New York: Metropolitan Museum of Art, 2005.
[15] Möller-Christesen, V. The History of the Forceps. Copenhagen: Levin and Munksgaard, 1938. 1.
[16] Kirkup, J. R. "The History and Evolution of Surgical Instruments, Part II: Origins, Functions, Carriage, and Manufacture." *Annals of the Royal College of Surgeons of England* 64 (1982): 125-32.

Egyptian doctors were regarded as some of the best of the Bronze Age, to the point where the rulers of other empires would ask the Egyptian pharaoh to send his best physicians to treat them or their loved ones.[17] Part of their skill came not only from the tools they possessed, but also from their knowledge of anatomy. The ancient Egyptians had a basic understanding of anatomy, as autopsy was necessary to carry out the Egyptian funerary practice of mummification. They even had prosthetics, though these were typically meant to be attached to the body after death in preparation for a proper burial and journey to the afterlife. As stated previously, ancient medicine was heavily interwoven with magic and spirituality, so the physicians of ancient Egypt were more akin to priest-physicians who employed amulets and spells in conjunction with their surgical practices and would assist the patient both in life as well as in death. The role of a priest-physician seems to be a specialized version of what had been the prehistoric "medicine man", only now the society had an organized religion to confer legitimacy on these practitioners.

Some of the oldest extant medical texts come from Egypt, with the Kahun Gynaecological Papyrus as the oldest Egyptian medical text to be discovered.[18] The Edwin Smith Papyrus, however, is the main text that discusses surgery in ancient Egypt; it is the only surviving copy of what must have been an entire textbook on trauma surgery.[19] The uniqueness of this text comes not from its age or style, but from the fact that it is one of, if not the only, medical papyrus from ancient Egypt that presents a rational and scientific approach to medicine rather than being based in magic.[20] Case histories are organized based on the organ in which the malady occurred, detailing injuries in a descending anatomical order not unlike a modern anatomical exposition.[21] Objective examination

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[17] Prioreschi, Plinio. *History of Medicine Volume 1: Primitive and Ancient Medicine*. Edwin Mellen Press: 1996. 257f.
[18] Griffith, Francis Ll. *The Petrie Papyri: Hieratic Papyri from Kahun and Gurob*. London: Quaritch, 1898.
[19] Ghalioungui, Paul. *Magic and Medical Science in Ancient Egypt*. New York: Barnes & Noble, 1965.
[20] Ibid.
[21] Breasted, James Henry. *The Edwin Smith Surgical Papyrus, Published in Facsimile and Hieroglyphic Transliteration with Translation and Commentary in Two Volumes*. Chicago, IL: University of Chicago, Oriental Institute, 1991.

processes are detailed with visual and olfactory cues, palpation, and taking of the pulse. The diagnosis and prognosis of each case are discussed, during which time the physician would judge the patient's chances of survival and recovery and would decide to treat the ailment, manage the ailment, or do nothing at all.[22] This papyrus also discusses treatment options, such as closing wounds with sutures and preventing infection with honey.[23] What makes this papyrus outstanding is the fact that the medical information related within it is objectively advanced for this time in human history; details and methodologies are presented that closely resemble how medicine is practiced today. Therefore, though it was still steeped mostly in magic and ritual, Egyptian medicine did have a logical foundation as well, based in observation and trial and error. This knowledge then served as a firm foundation upon which Hellenistic and Roman medicine could build.

As medicine began to develop in the Aegean, some, but not all, concepts from Egyptian medicine were incorporated. One very important corpus of knowledge that came over from Egypt was their knowledge of anatomy. The earliest pre-Hippocratic medical references from this region come from the *Iliad*, in which a plethora of medical and anatomical terms are mentioned. Doctors are mentioned as having participated in the campaign and are described wrapping and treating Menelaos' thoracic wound, caused by an arrow.[24] Given that the *Iliad* stems from a long-standing oral tradition in the Archaic Greek world, this medical knowledge must have been present in some aspect in Archaic Greece. How much of it was co-opted from Ancient Egypt cannot be said, but due to their local proximity and shared trade routes, the likelihood of some transfer of information from Egypt to Greece is quite high.

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[22] Ibid.
[23] Ibid.
[24] Apostolakis, Efstratios, Georgia Apostolaki, Mary Apostolaki, and Maria Chorti. "The Reported Thoracic Injuries in Homer's Iliad." *Journal of Cardiothoracic Surgery* 5, no. 1 (November 19, 2010): 119.

Then, sometime around the beginning of the fifth century BCE, Asclepius began to be worshipped as a god and a religious cult developed around his *mythos*.[25] He was considered to be a god of medicine, and his temples, called *asclepia (*s. *asklepion,* Ἀσκληπιεῖον), became centers of healing. The most famous of these early *asclepia* was in Epidaurus, and sick people would make pilgrimages to the site in hopes of being healed. The healing process involved ritual prayer and invocation of the gods, after which the patient would be put into a dream-like state of sleep induction called *enkoimesis* (ἐγκοίμησις), possibly using opium. The patient would then experience a vision of a god in his or her dreams and relay it to the priest-physicians, who would then determine the proper course for treatment.[26] These *asclepia* became centers for learning medicine, as well as practicing, allowing for the close study of patients and the dissemination of medical knowledge.

One of the most famous and important pre-Hellenistic physicians, who contributed immensely to the development of medicine and surgery in the Mediterranean, was Hippocrates. Born around 460 BCE on the island of Kos, he was most likely trained at the *asclepion* on the island, and he revolutionized medicine by being the first to claim that diseases had natural causes, rather than supernatural ones.[27] He separated medicine from religion by arguing that disease, rather than being punishment from the gods, was a product of environment, diet, and living habits.[28] Though magic and medicine had been almost inseparable up to this point, the theories of Hippocrates began to ground medicine in biology rather than theology. His treatment techniques for certain ailments,

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[25] Melfi, Milena. "Studia Archeologica 157." In *I Santuari Di Asclepio in Grecia*, 511. Roma: "L'ERMA" Di Bretschneider, 2007.
[26] Askitopoulou, Helen, *et. alia.,* "Surgical Cures under Sleep Induction in the Asclepieion of Epidauros." *International Congress Series* 1242 (December 2002): 11-17.
[27] Adams, Francis. *The Genuine Works of Hippocrates*. New York: William Wood and Company, 1891. 4.
[28] Hippocrates, *Collected Works I*. Edited by: W. H. S. Jones (trans.) Cambridge: Harvard University Press, 1868. 11.

e.g., hemorrhoids, were very advanced and his descriptions of proctoscopy and thoracic surgery are still valid today.[29]

Though his treatments were advanced, his ideas concerning the aeitological causes of disease were not. Hippocrates was responsible, along with the philosopher Empedocles, for applying the incorrect idea of *humorism* to medicine. This ideology held that the human body contained four distinct fluids that are in balance with each other when a person is healthy; they are black bile (μέλαινα χολή, *melaina chole*), yellow bile (κίτρινη χολή, *kitrine chole*), phlegm (φλέγμα, *phlegma*), and blood (αἷμα, *haima*). Disease was thought to arise when these humors were either contaminated or out of balance with each other, and every person was thought to have an individual balance of the four humors that would influence his or her personality. Though humorism would be disproved in the nineteenth century due to advances in cellular pathology, it would dominate Western medical thinking for over 2000 years – a testament to the outsized effect that Hippocrates had on Western medicine, whether his theories were wrong or right.

After the death of Hippocrates, Greek medicine began to split into different schools of thought and practice – Koan and Knidan. The Koan school, founded by Hippocrates himself, applied general diagnoses and passive treatments, focusing more on patient care and prognosis rather than diagnosis.[30] The Knidan school, based in Knidos, tried to focus more on diagnosis, but was unable to distinguish when one disease caused many possible kinds of symptoms due to their lack of modern understanding of anatomy and physiology. Both schools would contribute to the *Hippocratic Corpus*, however, which began to spur the study and development of medical practice.

New advances in biology and medical understanding would not occur again until the third and second centuries BCE in Hellenistic Egypt. Whereas in Greece the dissection of human bodies

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[29] Major, Ralph H. *Classic Descriptions of Disease*. New York: Classics of Medicine Library, 1994. 65.
[30] Smith, W.D. "Galen on Coans versus Cnidians." *Bulletin of the History of Medicine* 47, no. 6 (November/December 1973): 569-85.

was considered sacrilegious, the Ptolemaic dynasty allowed it for research purposes.[31] Led by physicians such as Herophilos of Chalcedon and Erasistratus of Iulis, Alexandria became the center of medical knowledge in antiquity.[32] Spurred by the creation of the Library of Alexandria, physicians brought their medical knowledge and expertise from around the Mediterranean to Alexandria.[33] Various schools of thought and practice developed and made sizable advances in anatomy, functional physiology, botany, pharmacology, and surgery. The physicians trained in Hellenistic Alexandria were considered to be among the finest in the world, and they would go on to practice and spread their medical knowledge in cities all around the Mediterranean basin.

After the Battle of Actium in 31 BCE, Rome became the undisputed superpower of the Mediterranean.[34] Though next to nothing is known about the life of the Roman physician Aulus Cornelius Celsus (c. 25 BCE – c. 50 CE), his work *De Medicina*, once part of a larger encyclopedia by Celsus, appears in the first century CE.[35] His work is among the first medical texts to be written exclusively in Latin, rather than Greek, and covers a brief history of medicine, along with general pathology, pharmacology, and surgery. He goes into great detail considering the preparation of ancient remedies, including opiates, and describes in detail a number of surgical procedures, from cataract removal to setting fractures. The fact that this work was written in Latin rather than Greek is significant, especially considering that most physicians in Rome were trained in the Greek-speaking East, and therefore the main language of medicine in antiquity was, historically, Greek.[36]

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[31] Serageldin, I. "Ancient Alexandria and the dawn of medical science." *Global Cardiology Science & Practice*, *2013*(4), 395–404.
[32] Ibid.
[33] Ibid.
[34] Davis, Paul K. *100 Decisive Battles from Ancient Times to the Present: The World's Major Battles and How They Shaped History*. Oxford: Oxford University Press, 1999. 63.
[35] Prioreschi, Plinio. *History of Medicine Volume 3: Roman Medicine.*. Horatius Press: 1999. 186.
[36] *Western Medical Thought from Antiquity to the Middle Ages*. Edited by Mirko D. Grmek. Compiled by Bernardino Fantini. Cambridge, MA: Harvard University Press, 2002. 111-20.

Also, since traditional Roman society was distrusting of most physicians,[37] it seems unlikely that this work would have been written solely to a general Roman audience. By writing his work in Latin, Celsus uses the new *lingua franca* of the Empire to make available to all its inhabitants a trove of medical information that would typically be available only in Greek and may have led the way for new physicians to be trained in Latin without the need to learn Greek.

Also writing during the first century CE was Pedianus Dioscorides, a Roman military surgeon from Asia Minor who traveled the empire extensively and wrote a five-volume *pharmacopeia* in Greek entitled Περὶ ὕλης ἰατρικῆς (*Peri hules iatrikes*) or, as it is known by its Latin translation, *De Materia Medica* ("On Medical Material"). His work gave detailed descriptions of over 600 plants along with their medicinal properties, and his work was groundbreaking enough that it formed the core of the European *pharmacopeia* for nearly 2000 years. The appearance of Celsus and Dioscorides in the record during the first century CE show that the corpus of medical knowledge, especially surgical knowledge comprised of Ancient Egyptian, Hellenic, and Hellenistic advancements, had already made its way to Rome and was being improved upon by physicians practicing in Rome itself and throughout the Empire.

Although there were many, the most well-known physician of the Roman Empire was the Greek physician Claudius Galenus (129 – c. 208 CE), better known as Galen. He was born to a wealthy family in Pergamon, a major cultural and intellectual center, where he learned Stoic and Platonic philosophy.[38] After studying for a while at the local *asclepion*, he traveled extensively throughout the empire, eventually going to Alexandria to further his studies in medicine. He went to Rome in 162 CE to make his mark as a practicing physician, but animosity developed between him and the "established" physicians of Rome, and he left the city a few years later.[39] He had already

[37] See Martial. *Epigrammaton*. Book V, No.9.; or Pliny the Elder. *Historia Naturalis*. Book XXIX, Chapter 7.
[38] Eichholz, D. E. "Galen and His Environment." *Greece and Rome* 20, no. 59 (1951): 60-71.
[39] Ibid.

made a name for himself during this time, though, and in 169 CE the emperor Marcus Aurelius summoned Galen back to Rome. After briefly accompanying the Antonine emperors on their military tour of Germany as the court physician, he became the court physician for both Commodus and Septimius Severus, and practiced in Rome until his death.[40]

The emperor Marcus Aurelius described Galen as "*Primum sane medicorum esse, philosophorum autem solum*" (first among doctors and unique among philosophers).[41] Because his works were not translated into Latin during antiquity, the study of his works fell into decline in Western Europe during the Early Middle Ages, when very few Latin scholars knew Greek. His works were preserved in the Eastern Byzantine Empire, however, and his writings come to us in the modern age after being translated from Greek into Arabic, and then into Latin during the Late Middle Ages. As medical observations advanced over time, many of Galen's anatomical observations and physiological theories would turn out to be incorrect, such as his adoption of humorism or the incorrectly-identified human anatomical structures that he postulated from his dissections on Barbary macaques.[42] His *corpus* made many correct contributions to the field of medicine as well, such as his theory that the brain is the center of control for the body and that cranial and peripheral nerves allow for voluntary movement.[43]

The works of Celsus and Galen, along with Dioscorides, represent the Roman culmination of thousands of years of medical and surgical experimentation in the Mediterranean basin. They embody the legacies of their Egyptian, Greek, and Hellenistic forefathers and display a vast knowledge of treating the human body for several afflictions. Their surgical knowledge and

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[40] Ibid.
[41] Galen. *De Praegnotione ad Epigenem*, 14:660.
[42] Furley, David J., and James S. Wilkie. *Galen: On Respiration and the Arteries*. Princeton, NJ: Princeton University Press, 1984.
[43] Frampton, M., *Embodiments of Will: Anatomical and Physiological Theories of Voluntary Animal Motion from Greek Antiquity to the Latin Middle Ages, 400 B.C.–A.D. 1300*, Saarbrücken: VDM Verlag, 2008. 180 – 323.

techniques were incredibly advanced when one considers that many successful procedures were developed alongside incorrect physiological theories such as humorism. From trepanation in the Neolithic to cataract surgery in Rome, the historical development of surgery was predicated on thousands of years of trial and error, coupled with the transmission of this medical knowledge among different developing societies. In the Mediterranean of antiquity, this knowledge and skill culminated in Rome and would continue to have a lasting effect on medical knowledge until after the Renaissance. To demonstrate the effectiveness of Roman medical knowledge, I will discuss anesthetics, tools, and techniques employed by surgeons during the Roman Empire; however, one cannot understand the significance of the state of surgery in Rome without an understanding of how this knowledge was developed over time across Mediterranean societies.

Chapter II: Roman Knowledge of and Use of Ancient Anesthetics

Surgery, no matter how advanced the Romans were, must have been an extremely painful and dangerous experience, in part from the lack of modern anesthetics (from the Greek words "αν αἴσθησις", or "without sensation")[44] that existed to put the patient under safely. We know the Romans inherited the collective medical knowledge of the Egyptian and Greek physicians, which would have included also an informal *pharmacopeia* of natural plants and herbs. Some of these plants could be used as "makeshift anesthetics". Solutions could be made from the extracts of these certain plants and either taken straight, or mixed into wine. Of course, these early anesthetics were also highly dangerous and not often used, since the anesthetizing compounds extracted from the plants can be highly lethal. Pliny identified a few examples of plants that were shown to have anesthetic-like properties.[45]

One of these plants is the mandrake.[46] The mandrake is actually a whole genus of plants belonging to the family Solanaceae, which is the family of nightshade plants[47]. What we commonly recognize as "the mandrake", the one that Pliny writes about, is the specific species *Mandragora officinarum*, native to Southern Europe and the Levant.[48] Pliny mentions in his *Natural History*, "The mandrake's leaves…are deadly. Too large a draught causes even death…It is also taken before surgery and injections to produce anesthesia".[49] Since most medicinal research in the Roman world came from the writings of the Greeks, much of Pliny's information on the mandrake would have come from the writings and research of earlier Greek physicians. When the Greek physician

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[44] Small, MR (1962). *Oliver Wendell Holmes*. New York: Twayne Publishers. 55.
[45] Pliny The Elder. "Materia Medica." In *Natural History: A Selection*, translated by John F. Healy, 226-43. London: Penguin Books, 1991.
[46] See Appendix: Figure 1 on page 35 for image.
[47] "Mandrake." In *Encyclopaedia Brittanica*, edited by Hugh Chisholm. 11th ed. London: Cambridge University Press, 1911.
[48] Pedanius, Dioscorides, Tess Anne. Osbaldeston, and Robert P. Wood. "Book Four: Other Herbs and Roots - Mandragoras." In *De Materia Medica*. Johannesburg: IBIDIS, 2000. 624-28.
[49] Pliny the Elder, 226-43.

Dioscorides wrote his five-volume *De Materia Medica* around 60 CE, he not only solidified the Roman *pharmacopeia*, but also included a whole section dealing with the mandrake plant and its potential anesthetic properties.[50] Since this *pharmacopeia* was published before Pliny's *Natural History*, and since the work would have circulated among physicians during this period, Pliny might have possibly used this work as a potential source for his own.

Ancient physicians must have observed that the root of the mandrake plant held the active ingredients that could induce sleep or death if ingested in a large enough quantity. Therefore, these physicians also must have experimented with dosages of mandrake root extract to find the optimal dose for surgery; however, no specific documents found in my research specifically detail the trial-and-error process of determining the optimal amount of extract. Pliny tells us, however, that the amount of mandrake root present in the extract should be "proportionate to [the patient's] strength, a medium dose being about 2 fluid ounces".[51] Therefore, a standardization of what constituted a small or medium dose of mandrake extract must have existed in some form in ancient Rome.

Several ways to ingest mandrake existed in ancient times. Only the root of the plant seemed to be used; the rest of the plant was discarded.[52] The most common form used for anesthetic purposes was the dried root. The root would be left in the sun to dry, and then the patient would chew on a small piece of the dried root before surgery. This would allow the plant to take its effect and put the patient to sleep for surgery.[53] Another method for ingesting mandrake was to crush the

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[50] Dioscorides, p. 626.
[51] Pliny The Elder. "Materia Medica." In *Natural History: A Selection*, translated by John F. Healy. London: Penguin Books, 1991. 242.
[52] "Mandragora." In *The Herbal of Pseudo-Apuleius*, edited by Friedrich Wilhelm Hunger and J.P. Lignamine, by Apuleius Barbarus. Leyden: E.J. Brill, 1935. 72-76.
[53] Calahan, Michael D. *Clinical Anesthesia*. By Paul G. Barash, Bruce F. Cullen, and Robert K. Stoelting. Hagerstown: Lippincott, Williams & Wilkins, 2009. 592.

fresh root with a mortar and pestle and then store the juice extract, which could be added to wine or water to take as a draught.[54]

While the ancient Greeks and Romans may not have understood why the mandrake plant made a suitable anesthetic, modern scientific research has been able to shed some light on the issue. The mandrake plant contains several chemical compounds called tropane alkaloids. In fact, almost all members of the plant family Solanaceae contain varying concentrations of these molecules. The concentration of tropane alkaloids seems to be highest in the root of the mandrake plant, which is why that part of the plant worked best as a mild anesthetic. When introduced into the body, these molecules have an anticholinergic effect. This means that a certain neurotransmitter called acetylcholine, which is partly responsible for all involuntary muscle movements in the body, gets blocked from binding to their specific parasympathetic receptors. This in turn reduces muscle spasms and fluid secretions within the patient and relaxes the patient for surgery.[55] General side effects would have included dry mouth and throat, eye pain, blurred vision, feelings of dizziness and faintness, and some short-term memory loss. Too much, however, can induce an irreversible coma or even stop a person's heart.[56]

As stated above, the mandrake plant is not the only species in its family that is capable of producing anesthetic-like effects. Henbane, or *Hyoscyamus niger*, was also used in conjunction with mandrake to produce an anesthetic-like potion.[57] Henbane, another member of the family Solanaceae, contains many of the same chemicals that are found in mandrake, except that henbane

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[54] Ibid.
[55] Fox, C., et al. "Effect of Medications with Anti-cholinergic Properties on Cognitive Function, Delirium, Physical Function and Mortality: A Systematic Review." *Age and Ageing* 43, no. 5 (September 19, 2014): 604-15.
[56] Calahan, 592.
[57] *Alkaloids Biochemistry, Ecology, and Medicinal Applications.* Edited by Margaret F. Roberts and Michael Wink. Berlin: Springer Verlag, 1998. 31-32.

tends to have more of a psychedelic effect. Henbane was also known to the ancients as *Herba Apollinaris*, since it was used by the priestesses of Apollo to obtain oracles,[58] and Dioscorides recommended it as a sedative and analgesic.[59] Its method of preparation and harvesting are very similar to mandrake.[60]

As a point of reference, modern anesthesia is essentially a reversible, drug-induced coma that suspends somatic nervous system functions while simultaneously maintaining autonomic nervous function. This means that, even though the patient is in an unconscious state, their cardiovascular and respiratory systems continue to function normally. The experience of anesthesia in the ancient world would have been much different from how we know anesthesia. Since no way existed to induce safely a fully reversible coma in the first and second centuries CE, a mandrake and/or henbane-based anesthesia would not induce complete unconsciousness as we know it – rather, the patient would be in a twilight state of reduced pain, but still may be able to perceive certain parts of the surgery.

Luckily, the plants Solanaceae were not the only ones in the *pharmacopeia* that could be used for anesthetic purposes. Pliny also identified *Papaver somniferum*, or the opium poppy.[61] The plant is indigenous to Asia Minor, but was distributed and grown all throughout southern Europe and Asia. Like the mandrake, Pliny says that the juice from the poppy, or opium, is "not only sleep-inducing but, if too much is swallowed, brings about a fatal coma".[62] Opium, however, was discovered long before the Greeks wrote about it. The earliest recorded use of opium to relieve pain and induce

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[58] Calahan, 592.
[59] Grieve, Maud (1971). *A Modern Herbal: The Medicinal, Culinary, Cosmetic and Economic Properties, Cultivation and Folk-lore of Herbs, Grasses, Fungi, Shrubs, & Trees with All Their Modern Scientific Uses, Volume 1*.
[60] Ibid.
[61] See Appendix: Figure 2 on page 35 for image.
[62] Pliny The Elder. 227.

sleep was by the Sumerians around 4000 BCE.[63] Most doctors preferred the use of opium as an anesthetic compared to mandrake root because it was much safer and patients could be given a larger dose without the almost-certain possibility of death. Ancient physicians had some mixed reviews about the widespread use of opium, however. On the one hand, Galen writes in the second century CE that it could be a potential cure for most diseases.[64] On the other hand, the Greek physician Erasistratrus warned of the potential danger resulting from having to constantly increase the administered dosages of opium (written much earlier than Galen, in the third century BCE).[65]

Creating an anesthetic from opium is much harder and more time-consuming than creating an anesthetic from mandrake or henbane. The opium extraction and preparation process was, and still is, an extremely time-consuming and laborious endeavor. The poppy seedpods are scored several times by a sharp blade, which allows the white latex of the plant to seep out. The seedpod must be fresh, and the score marks must be superficial to keep from opening the inner seed chambers and ruining the pod.[66] The latex then dries to the outside of the pod and is collected a few hours later by scraping it off of the seedpod.[67] The resin is a sticky, brown substance, which actually contains the morphine used in the anesthetics. The resin can be pressed and dried into "chips" to be eaten, or it can be dissolved in wine and drunk before surgery. The yield of extracted opium is very low, however, with one high-quality Afghan poppy producing only 500 mg of latex. Reports claim that one individual would need the latex from 15 pods in order to achieve the desired anesthetic effect.[68]

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[63] Krikorian, Abraham D. "Were the Opium Poppy and Opium Known in the Ancient near East?" *Journal of the History of Biology* 8, no. 1 (Spring 1975): 95-114.
[64] Krikorian, 95-114.
[65] Krikorian, 95-114.
[66] Aggrawal, Anil. "Chapter 2: The Story of Opium." In *Narcotic Drugs*. New Delhi: National Book Trust, India, 1995. 22-29.
[67] Krikorian, 95-114.
[68] Shuljgin, G. *Cultivation of the Opium Poppy and the Oil Poppy in the Soviet Union*. Report. Washington, DC, 1969. Accessed April 28, 2014.

Modern science has been able to shed light on how opium produces its effects. Opium resin contains a class of compounds called phenathrene alkaloids, specifically morphine and codeine. Because these alkaloids directly affect the brain, or central nervous system (CNS), opium is much faster acting than mandrake root. The alkaloids in mandrake bark affect the other nerves in the body, or the peripheral nervous system (PNS). Opium effects include feelings of euphoria, analgesia (reduction of pain), and eventually sedation. Too much opium, however, will lead to renal failure and asphyxiation by respiratory depression.[69] Also, the body develops a tolerance to opium over time, so increasing dosages are necessary to achieve the desired effects – which can be deadly if too much opium is taken at once. So, while opium may be more desirable to use as an anesthetic and pain reliever than mandrake or henbane, these could be used if opium was not available.

Because ancient surgeries were extremely painful and dangerous medical techniques, a need must have arisen for an anesthetic of some sort to subdue the patient and make surgeries somewhat safer. Pliny mentions in his *Natural History* both the mandrake and the opium poppy as two plant sources of natural anesthetics.[70] The opium poppy, using observed evidence from ancient Greek physicians as well as modern scientific research, proved to be a much safer and less lethal anesthetic than mandrake root. Opium, however, has a high chance of inducing a physical dependence to it, and producing and refining it for medical use is also extremely laborious and time-intensive. The plants Solanaceae have virtually no chance of causing a physical dependence, and their compounds are very easy to extract. They are, however, much more toxic than opium, and they produce many unwanted and unpleasant side effects. Either way, ancient anesthetics were very risky to use, adding to the overall danger of surgical treatment in antiquity.

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[69] Jenkins, A. J. "Pharmacokinetics of Opium." In *Pharmacokinetics and Pharmacodynamics of Abused Drugs*, compiled by Steven B. Karch. Boca Raton: CRC Press, 2008.
[70] Pliny The Elder. "Materia Medica." In *Natural History: A Selection*, translated by John F. Healy, 226-43. London: Penguin Books, 1991.

Chapter III: Surgical Tools in the Roman Empire

No proper conception of a surgical operation, ancient or modern, can be formed from written description without some knowledge of the instruments being used. Many detailed operations described by the classical authors can be rendered obscure or quite unintelligible from the lack of this knowledge; for how can one understand the intricacies of these procedures without understanding the instruments that were used to perform them? It is not until the writings of Hippocrates in the fifth century BCE that we begin to read about the instruments used for surgical practices in the historical record. To demonstrate what the Roman physicians had available to them, I describe various tools found in the archaeological record and discuss their origins and uses.

Most surgical tools encountered in the archaeological record are bronze.[71] We do know, however, that iron tools were also employed. A general tendency exists to underestimate the extent to which iron was in use for medical instruments due to the lack of examples in the archaeological record; however, the use of iron is thought to have been widespread for creating basic surgical instruments.[72] The writings of Galen reveal that the best quality iron, from the Alpine province of Noricum, yielded the best quality surgical knives:

"Εκ σιδήρου δὲ ἔστω τοῦτο τοῦ καλλίστου, οἷον περ τὸ Νωρικόν ἐστιν, ἵνα μήτ' ἀμβλύνηται ταχέως, μήτ' ἀνακάμπτηται ἢ θραύηται."[73]

"Let this knife be made from the most beautiful iron, especially Norican iron, in order that [the knife] may neither be dulled swiftly, nor bent back or broken."

This passage from Galen shows that the adept surgeon not only appreciated good iron for their tools, but also highlights a potential difficulty in obtaining top-quality surgical tools. The origin of

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[71] Milne, John Stewart, M.D. "Chapter II: Material, Execution, and Ornamentation." *Surgical Instruments in Greek and Roman Times*. Master's thesis, University of Aberdeen, 1907. Oxford: Clarendon Press. p.10.
[72] Ibid.
[73] Galen. "De Anatomicis Administrationibus I-IX,5." In *Claudii Galeni Opera Omnia*, edited by Karl Gottlob Kühn, Vol. 2. Book 8, Section 6. Leipzig: Cnobloch, 1821. Accessed online at *A Digital Corpus for Graeco-Arabic Studies*, Harvard and Tufts Universities.

the metal used, and therefore the purity of the metal, obviously made a noticeable difference in the reliability of the tool, and it was common knowledge that certain areas produced higher-grade metals than other areas. A skilled physician in ancient Rome would have had to know which areas produced higher-quality metals and which instruments those metals would be best suited for, as well as where to obtain these instruments in the first place.

Though iron was widely used for the creation of medical instruments, most examples of surgical tools found in the archaeological record are bronze.[74] Unlike iron, which can completely and thoroughly oxidize over time, bronze only oxidizes superficially, a process that leaves a layer of patina coating the metal. This superficial patina ensures the integrity of the underlying metal by protecting it from further corrosion, which is how so many bronze artifacts remain in the archaeological record.[75] Bronze was used not only for a wide array of tools, but also for vessels, bloodletting cups, catheters, probes, and *spathomelae* (spatula probes).[76]

Though bronze and iron were the principal metals used in the creation of Roman medical instruments, other materials were used as well. Hippocrates mentions uterine dilators made of tin so that they might be flexible,[77] and Soranus mentions lead tubes for vaginal fumigation[78]. Examples of tin and lead probes have also been found in the archaeological record.[79] Since these metals by nature are softer and more malleable than bronze or iron, they prove useful for the creation of instruments

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[74] Milne, John Stewart, M.D. "Chapter II: Material, Execution, and Ornamentation." *Surgical Instruments in Greek and Roman Times*. Master's thesis, University of Aberdeen, 1907. Oxford: Clarendon Press. p.10.
[75] Fitzgerald, K.P., J. Nairn, and A. Atrens. "The Chemistry of Copper Patination." *Corrosion Science* 40, no. 12 (1998): 2029-050.
[76] "Surgical Instruments from Ancient Rome." University of Virginia Claude Moore Health Services Library. Accessed online at exhibits.hsl.virginia.edu. University of Virginia. http://exhibits.hsl.virginia.edu/romansurgical/
[77] Hippocrates. "On Diseases of Women." In *Oeuvres complètes d'Hippocrate: Traduction nouvelle avec le texte grec en regard*, edited by Emile Littré. Vol. 8. Book 1, Section 60. Paris: J.B. Baillière, 1861. 118.
[78] Soranus. "IV." In *Soranus' Gynecology*, edited by Owsei Temkin, 14-15. Baltimore: Johns Hopkins Univ. Press, 1991.
[79] Jackson, Ralph. "The History and Evolution of Surgical Instruments." In *Doctors and Diseases in the Roman Empire*, 57. London: British Museum Press, 2000.

that could be more easily inserted and manipulated within the anus or the vagina. Silver and gold were also used to decorate or overlay metal instruments, and sometimes bleeding-cups were made from silver.[80] These lavish instruments, though visually appealing, did not seem to enhance the properties of the instrument in any way. In fact, the second-century satirist Lucian writes that he would prefer a knowledgeable surgeon with a rusty knife than a charlatan with precious equipment.[81] Although some decoration was purely for show, some decoration could serve a practical function as well, such as the fine mouldings on slender instruments that would allow a physician to ensure a tighter grip.[82]

Other non-metallic materials were used to create medical instruments as well. Hippocrates mentions a pessary of horn that was to be inserted into the rectum, and the tubes of various syringes were sometimes made of horn, as Scribonius Largus writes in the first century CE:

"Per nares ergo purgatur caput his rebus infusis per cornu, quod rhinenchytes vocatur…"[83]

"Through the nose, therefore, the head is cleared with these things infused through a horn, which is called *rhinenchytes*…"

Galen also mentions ointment *spatulae* of made of wood, as well as boxes for storing ointments, and many ligulae (spoons) found at a dig in Baden that were made of bone or ivory. Knife handles of bone or ivory were also common, and an ivory pestle was found in Cologne among a Roman surgeon's tool collection. Roman medical instruments, though mostly bronze and iron, could be made from a variety of different materials to suit the needs of the practicing physician.

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[80] Milne, John Stewart, M.D. "Chapter II: Material, Execution and Ornamentation." In *Surgical Instruments in Greek and Roman Times*. Master's thesis, University of Aberdeen, 1907. Oxford: Clarendon Press. p.16.
[81] Lucian. *Adversus indoctum et libros multos ementem*. Section 3.29. Accessed online via The Perseus Project. Tufts University.
[82] Milne, 16.
[83] Scribonius Largus. *Compositiones*, 7.1. Accessed online at Classical Latin Texts, The Packard Humanities Institute.

The essential instruments of a surgeon's *instrumentarium* included knives, probes, forceps, hooks, and cups for blood-letting.[84] The most common design for a surgical knife in ancient Rome was to have a handle made of bronze, with the blade being made of iron;[85] examples can be seen in Figure 3 of the Appendix on page 36. A slot would be made at one end of the bronze bar to receive the iron blade, and the blade would be fixed in the handle by a binding thread or wire; this design could allow for the removal of the blade for cleaning, or to replace the blade if it became damaged, but in most cases the blade was either luted or brazed in permanently.[86] On the one hand, the blade itself could be either straight or curved, with one or two edges, and a number of variations on this theme exist. For instance, Hippocrates uses the word μάχαιρα (*makhaira*) or μαχαίριον (*makhairion*) to refer to an "ordinary scalpel" with a straight, sharp-pointed blade, whereas he refers to a phlebotome (for purposes of venesection) as ὀξυβελής (*oxubelaes*, "sharp-pointed").[87] On the other hand, Celsus uses the word ***scalpellus*** (scalpel) to denote a wide variety of surgical knives with different shapes,[88] so physicians seem to have had many different words to describe their instruments.

Probes were used extensively by Roman surgeons to dilate strictures and detect foreign bodies or stones within body cavities. In describing the procedure for diagnosis of a rectal fistula, Celsus writes:

"Ante omnia autem demitti specillum in fistulam convenit, ut quo tendat et quam alte perveniat scire possimus; simul etiam protinus humida an siccior sit: quod extracto specillo patet."[89]

"But above all it is well to lower the probe into the fistula to learn where it goes and how deeply it reaches, also whether it is moist or rather dry, as is detected when the probe is withdrawn."

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[84] Jackson, Ralph. "The Surgeon and the Army." In *Doctors and Diseases in the Roman Empire*, 114. London: British Museum Press, 2000.
[85] Milne, John Stewart, M.D. "Chapter III: Knives." In *Surgical Instruments in Greek and Roman Times*. Master's thesis, University of Aberdeen, 1907. Oxford: Clarendon Press. p.25.
[86] Ibid.
[87] Ibid.
[88] Ibid.
[89] Celsus. *De medicina*, Book VIII. Page 213, line 12c. Accessed online at Perseus Project. Tufts University.

Celsus defines the probe by using the word ***specillum***, while the Greeks referred to it as ἡ μήλη (*hē mēle*, "the probe")[90], and his remark demonstrates that he, along with many other ancient physicians, possessed the *tactus eruditus* of using the probe to a high degree. The tips of the extant probes vary in size considerably, with some possessing a sharp point like a stylet, and others that end in a rounded or oval enlargement.[91] Sometimes a probe would actually have its other end fashioned to serve a different purpose, such as spatula probes (*spathomelae*), or hooked probes[92] - examples of spatula probes can be seen in Figure 4 of the Appendix on page 36. Also, while these probes were used for exploration and surgical purposes, they were also used for the application of medicaments and toilet preparations.[93] The flat end of a *spathomela* could even be heated up and used as a cautery.[94]

Bloodletting by means of cupping has been practiced since ancient Egypt, but gained popularity after it spread to the Greeks and Romans.[95] The widespread nature of this practice, along with how commonly it was practiced, made cups an important part of the physician's toolbox. The practice itself derived from the humorist theory that blood, as the dominant humor, could "stagnate" in the extremities and be responsible for upsetting the balance of humors in the body.[96] Disease would then follow from this condition. Galen created a complex system by which certain specific veins or arteries would be let depending on which organ was diseased (for example, letting the vein in the right hand to remedy a liver condition), and this system of bloodletting certain areas remained in practice until well into the 1800s.[97]

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[90] Milne, John Stewart, M.D. "Chapter IV: Probes." In *Surgical Instruments in Greek and Roman Times*. Master's thesis, University of Aberdeen, 1907. Oxford: Clarendon Press. p.52.
[91] Ibid, 54.
[92] Ibid, 56.
[93] Ibid, 56.
[94] Ibid, 60.
[95] Seigworth, Gilbert R. (1980). "Bloodletting Over the Centuries". *Red Gold, the Epic Study of Blood*. PBS. Archived from the original on July 5, 2007.
[96] Conrad, Lawrence I. *The Western Medical Tradition: 800 B.C.-1800 A.D.* Cambridge: Cambridge University Press, 2011.
[97] Ibid.

Cups were typically made from bronze or horn; silver cups also existed, but they can heat too readily and burn the patient.[98] Glass cups could also be used if one wanted to mark the quantity of blood extracted. After venesection, the cup would be placed over the open wound and heated, usually with a burning wick attached inside the cup.[99] The purpose of this was to create a vacuum inside the cup that would suction the blood out of the open wound, and in more primitive designs, the cups worked by suction alone without the use of heat.[100] Examples of bloodletting cups can be seen in Figure 5 of the appendix on page 36.

A surgeon's *instrumentarium* could consist of other, more specialized tools as well.[101] As mentioned earlier, the trephining drill has been in use since early antiquity and was most certainly a part of the Roman surgeon's *corpus* of tools. For operations on bone, Celsus mentions the ***serrula*** (saw)[102], and Galen mentions bone levers (μοχλίσκος, *mokhliskos*) for levering fractured bones into position.[103] Another tool that used by surgeons in the Roman military is described by Celsus as the κυαθίσκος Διοκλεῖος (*kuathiskos Diokleios*), or the Scoop of Diocles[104], a special instrument designed for extracting arrow heads or broad weapons from punctured flesh. For gynecological purposes, a surgeon may have a vaginal *speculum* (διόπτερα, *dioptera*) consisting of two flat pieces operated by a turning screw, in order to examine the vagina and uterus for *fistulae* or other maladies.[105] Bronze and tin catheters were also in existence to aid in the removal of renal stones, as well as to draw urine out of an excessively-dilated bladder.[106]

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[98] Milne, John Stewart, M.D. "Chapter VI: Cups." In *Surgical Instruments in Greek and Roman Times*. Master's thesis, University of Aberdeen, 1907. Oxford: Clarendon Press. p.103.
[99] Ibid.
[100] Ibid.
[101] See Appendix: Figures 6-8 on page 37 for examples and images.
[102] Ibid, "Chapter VIII: Bone and Tooth Instruments." p.131.
[103] Ibid, 134.
[104] Ibid, 142.
[105] Ibid, "Chapter IX: Bladder and Gynaecological Instruments." p.151.
[106] Ibid, 144.

Ancient Roman physicians had a plethora of different instruments to use in their practice, made from various metals as well as non-metallic substances. They demonstrated an understanding of how to use these tools effectively, as confirmed by the writings of those such as Celsus and Galen. Not much is known about how physicians went about obtaining their tools – certain craftsmen theoretically could specialize in producing medical instruments, but no evidence exists to suggest that every instrument in the entire Roman medical *corpus* would be available to every practicing physician. Certain instruments, especially the more advanced and specialized ones, would most likely cost more money and be harder to procure than simple knives or probes. Even so, the large variety of medical instruments used by the ancient Romans reveals to us a society that was fully capable of performing advanced medical procedures with moderate to high chances of survival.

Chapter IV: Case Studies of Ancient Roman Surgical Procedures

Some of the best descriptions of the practice of surgery in the Roman Empire come from the writings of Aulus Cornelius Celsus (c.25 BCE – c.50 CE)[107], but doubts exist as to whether he himself actually practiced surgery, or if he was an encyclopedist collecting and organizing the medical knowledge that existed during his time.[108] For a Roman nobleman to have a basic knowledge of medicine during the first century CE was not considered to be unusual, but its physical practice by Romans was looked down upon in Roman society.[109] A close examination of his descriptions of surgical practices, however, shows that he not only possessed a considerable amount of medical knowledge, but that he was a true *artifex medicinae* whose work inaugurated a new medical nomenclature for the Latin language.[110] By examining a few of his surgical procedures we can evaluate the state of surgical knowledge in the Roman empire.

One kind of injury that Celsus describes, one that was probably more common among Romans in the military than civilians, was the puncturing of the abdominal wall. In describing this procedure, Celsus writes:

> *"Sometimes the abdomen is penetrated by a stab of some sort, and it follows that intestines roll out. When this happens, we must first examine whether they are uninjured, and then whether their proper colour persists. […] The larger intestine can be sutured…for occasionally it heals up. Then if either intestine is livid or pallid or black, in which case there is necessarily no sensation, all medical aid is vain. […] The patient is to be laid on his back with his hips raised; and if the wound is too narrow for the intestines to be easily replaced, it is to be cut until sufficiently wide. If the intestines have already become too dry, they are to be bathed with water. […] Next the assistant should gently separate the margins of the wound by means of his hands, or even by two hooks inserted into the inner membrane […] Now stitching of the surface skin only or of the inner membrane only is not enough, but both must be stitched. And there must be two rows of stitches, set closer*

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[107] Scott, William A. "The Practice of Medicine in Ancient Rome." *Canadian Anaesthetists' Society Journal* 2, no. 3 (July 1955): 281-90.
[108] Ibid, 281.
[109] Ibid, 289.
[110] Meinecke, Bruno. "Aulus Cornelius Celsus—plagiarist or Artifex Medicinae?" *Bulletin of the History of Medicine* 10 (1941): 288-98.

> *together than in other places, partly because they can be broken here more easily by the abdominal movement…"*[111]

This passage tells us much more about Celsus' knowledge of treating abdominal trauma than one would expect. He has not only described a successful method of treating stab wounds with prolapsed intestine, but he has also made some important points about performing abdominal surgery in general.

For instance, he makes a point in his procedure to note the color of the intestine; he must have known that the intestine's color could be used to elucidate the condition of its vascular supply. For if the intestine appears pallid or black, its blood supply is restricted and the tissue could necrotize, for which there was no treatment at that time. He also must have known how sensitive intestinal tissue is, due to his recommendation to enlarge the wound if necessary as to prevent damaging the intestine during reposition, as well as how quickly it can dry out when exposed to air – which is why he recommends a water bath to rehydrate it before repositioning. His advice on how to suture the wound conveys an intimate knowledge of abdominal anatomy, since both the surface skin and the inner membrane of the abdominal wall must be sutured together to secure the repositioned intestine. In fact, his descriptions and recommendations are accurate enough that modern abdominal surgeons rely on many of the same principles, experiences, and recommendations that he describes for the closing the wound and repositioning the injured intestine.[112]

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[111] Celsus, A. C. *De Medicina (On Medicine),* Book VII. Loeb Classical Library Edition, Cambridge: Harvard University Press, 1935. p. 387.
[112] Sachs, Michael. *Geschichte Der Operativen Chirurgie*. Heidelberg: Kaden, 2001.

For treatment of an umbilical hernia, caused by a hole in the abdominal wall behind the navel and resulting in the herniation of the greater omentum or parts of the small intestine[113], Celsus writes:

> *"Of course the patient must be laid on his back, in order that the swelling, whether it be intestine or omentum, may slip back into the abdomen. But when the navel sac was then empty, some caught it between two little rods, and fastened the ends of the rods tightly together, so that it mortified there; some passed a needle doubly threaded through the base of the sac, then knotted the two ends of each thread on opposite sides, as is done also in staphyloma of the eye; for in this way that part beyond the ligatures mortifies. Some, in addition, before tying the ends also cut into the protrusion along a marked line and excised it:[…]"*[114]

One remarkable aspect of this description is that no other physician before Celsus has described this kind of surgery; though hernia is mentioned in the writings of earlier physicians, the most complete and scientifically sound reference we have for surgically treating umbilical hernias belongs to Celsus.[115] He writes that the patient must lie on his or her back, in order that the herniated tissue might slip back into the abdomen. After this occurs, the distended navel sac could then be ligated by passing a doubly-threaded needle through the sac's basal membrane and knotting the two ends of the thread on opposite sides of the sac. This procedure not only closes the fascial defect and separates the navel sac from the abdomen, but also allows for a full excision of the distended sac.

The instrument that would have been required to perform this procedure is a curved needle with an eyelet, to allow for the threading of two strings.[116] An example of this kind of instrument was found as a burial object in a dig at Ephesus, dating to c. 100 CE.[117] Surgical needles in the

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[113] Papagrigoriadis, S., D. J. Browse, and E. R. Howard. "Incarceration of Umbilical Hernias in Children: A Rare but Important Complication." *Pediatric Surgery International* 14, no. 3 (1998): 231-32.
[114] Celsus, A. C. *De Medicina (On Medicine),* Book VII. Loeb Classical Library Edition, Cambridge: Harvard University Press, 1935. p. 381.
[115] Papavramidou, N.S., and H. Christopoulou-Aletras. "Treatment of "hernia" in the Writings of Celsus (first Century AD)." *World Journal of Surgery* 29, no. 10 (October 2005): 1343-347.
[116] Köckerling, F., D. Köckerling, and C. Lomas. "Cornelius Celsus—ancient Encyclopedist, Surgeon–scientist, or Master of Surgery?" *Langenbeck's Archive of Surgery* 398, no. 4 (April 2013): 609-16.
[117] See Appendix: Figure 9 on page 38 for image. Found in: Kunzl, Ernst, and Franz Josef Hassel. *Medizinische Instrumente Aus Sepulkralfunden Der Römischen Kaiserzeit.* Köln: Rheinland, 1983.

modern day are also curved, since we now know that this shape facilitates suturing and tissue penetration[118]; the Romans were aware of the benefits of using a curved needle for suturing and ligatures, and they used this knowledge and technology to their benefit.

Celsus also mentions in his description that the procedure for ligating the navel sac is the same technique used in treating a staphyloma of the eye. A staphyloma is much like a hernia of the eye, in which an abnormal protrusion of underlying pigmented uveal tissue develops through a weak point in the outer scleral tissue.[119] Though he only mentions this as an aside, this line reveals that the Romans not only had knowledge of ophthalmic surgery, a further testament to the remarkable amount of medical knowledge and technology they possessed, but that certain surgical procedures could be co-opted to treat conditions in different areas of the body. We do not know what the success rate of this surgery would have been; however, a procedure of that sort on the eye would require, besides a much smaller needle, a surgeon with the knowledge and dexterity to be able to perform this operation – a further testament to the Romans' knowledge of surgical procedures and their understanding of the human body.

Another surgical procedure proposed by Celsus involves the treatment of anal fistulae. An anal fistula is an abnormal tunnel that can develop between the epithelial surface of the inner anal canal and the external perianal skin.[120] They typically begin as an abscess, which then bursts and fails to heal, or is not drained properly.[121] This can become quite painful, especially when pus begins to build up within the fistula. Concerning its treatment, Celsus writes:

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[118] McCredie, J.A., and G.P. Burns, eds. *Basic Surgery.* 2nd ed. New York: Macmillan Publishing, 1977.
[119] "Myopia: A Historical Perspective." In *Pathologic Myopia*, edited by Richard F. Spaide, Kyoko Ohno-Matsui, and Lawrence A. Yannuzzi. New York: Springer-Verlag, 2016. p.5.
[120] "Chapter 12: Proctology - Anorectal Sinuses and Fistulae." In *Primary Surgery: Non-Trauma*, edited by Maurice King, Peter C. Bewes, James Cairnes, and Jim Thornton. Vol. 1. Cambridge: Oxford University Press, 1990.
[121] Ibid.

> *"Special consideration is required in the case of those in the anus. In these, where a probe has been passed up to its end, the skin should be cut through, next through this new orifice the probe is to be drawn out, followed by a linen thread which has been passed through the eye made for the purpose in the other end of the probe. Then the two ends of the linen thread are taken and knotted together so as to grip loosely the skin overlying the fistula. The linen thread should be made up of two or three strands of raw flax, twisted up so as to make one. Meanwhile the patient can do his business, walk, bathe, and take food as if in the best of health.[…]"*[122]

When treating a fistula, a total excision would irreparably damage the sphincter muscle itself, resulting in incontinence.[123] Remarkably, the ancient Romans must have known this, since excision was deliberately avoided. Rather, a probe with a linen thread attached to its eyelet would be inserted into the superficial opening of the fistula and drawn back out through the anus. The two ends of the thread would be knotted, to allow for the drainage of pus and facilitate healing. Variations on this approach for treating fistulae are used in modern surgery as well, being called the "seton techniques", and they have been shown to eradicate fistulae successfully.[124] Upon reading Celsus, one can see that a great deal of conformity exists between ancient surgical approaches and techniques and their modern equivalences. Celsus describes some major operations, even by modern standards, and it would behoove many physicians to know that much that is considered modern was well understood by the ancients.

The three case studies presented all deal with potentially life-threatening injuries or conditions, but surgery for cosmetic purposes also existed in ancient Rome. One particularly shocking set of procedures described by Celsus are methods for restoring the prepuce, or foreskin, which one could call a "decircumcision."[125] The ancient Greeks, and later the ancient Romans,

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[122] Celsus, A. C. *De Medicina (On Medicine),* Book VII. Loeb Classical Library Edition, Cambridge: Harvard University Press, 1935. p. 313.
[123] Parks, A.G. "Pathogenesis and Treatment of Fistula-in-Ano." *British Medical Journal* 1, no. 5224 (1961): 463-9.
[124] Subhas, Gokulakkrishna, et al. "Setons in the Treatment of Anal Fistula: Review of Variations in Materials and Techniques." *Digestive Surgery* 29, no. 4 (2012): 292-300.
[125] Rubin, Jody P. "Celsus' Decircumcision Operation: Medical and Historical Implications." *Urology* 16, no. 1 (July 1980): 121-24.

celebrated the form of the nude body in art and sport and would have considered any abnormal appearance of the male genitals as socially unacceptable[126]; in fact, the first century CE writer Petronius encapsulates this attitude with his declaration: "Yet [this slave] has two faults (*duo vitia*) which if he did not have, he would be perfect: he is circumcised (*recutitus*), and he snores."[127] Also, a common practice to prevent the retraction of the prepuce in public was to undergo infibulation, where a safety pin-like instrument known as a *fibula* would be attached to the distal edge of the prepuce.[128] So, surgical procedures were developed *decoris causa* for those who either had undergone circumcision or had been born with little or no prepuce, in order that he might participate inconspicuously in Greco-Roman society.

Two different variations on this procedure are presented, depending on the condition of the penis in question. Celsus begins by noting that these procedures are performed more easily on young boys than on grown men, and on those who were born with a defect of the prepuce rather than those who were purposely circumcised.[129] This makes sense considering that on younger, uncircumcised boys, there would be a greater proportion of skin to penis that could be worked with, and the healing process would take less time.[130]

For those who are uncircumcised but have a congenitally insufficient prepuce, Celsus writes:

> "The prepuce around the glans is seized, stretched out until it actually covers the glans, and there tied. Next the skin covering the penis just in front of the pubes is cut through in a circle until the penis is bared, but great care is taken not to cut into the urethra, nor into the blood vessels there. This done, the prepuce slides forward towards the tie, and a sort of small ring is laid bare in front of the pubes, to which linen is applied in order that flesh may grow and fill it up."[131]

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126 Warren, H. C. "Social Nudism and the Body Taboo." *Psychological Review* 40, no. 2 (1933): 160-83.
127 Petronius. *Satyricon*, Section 68, Line 8. Accessed online via the Perseus Project. Tufts University.
128 Celsus, A. C. *De Medicina*, Book VII, Chapter 25. Accessed online via the Perseus Project. Tufts University.
129 Ibid.
130 Rubin, Jody P. "Celsus' Decircumcision Operation: Medical and Historical Implications." *Urology* 16, no. 1 (July 1980): 121-24.
131 Celsus, A. C. *De Medicina*, Book VII, Chapter 25. Accessed online via the Perseus Project. Tufts University.

To summarize, a shallow cut is made around the base of the penis, separating the superficial phallic integument from the subcutaneous areolar tissue. This skin is then pulled forward down over the glans, much like a glove, to form a new prepuce; this distal end of this double layer of skin is then tied with a ring to prevent the skin from slipping back up the shaft. Extensive scarring around the base of the penis would be expected, along with a strong pull exerted on the skin by the retraction of the annular scar around the base of the penis.[132] Celsus also does not mention a need for a plaster dressing in this operation; because the skin next to the glans is just preputial dermis, the dermis will not adhere to the glans during the healing process.[133] For an image depicting this procedure, see Figure 10 in the appendix on page 38.

In cases where the penis has been circumcised, the procedure is more intensive. Celsus writes:

> "But in one who has been circumcised the prepuce is to be raised from the underlying penis around the circumference of the glans by means of a scalpel. This is not so very painful, for once the margin has been freed, it can be stripped up by hand as far back as the pubes, nor in so doing is there any bleeding. The prepuce thus freed is again stretched forwards beyond the glans; next cold water affusions are freely used, and a plaster is applied round to repress severe inflammation. And for the following days the patient is to fast until nearly overcome by hunger lest satiety excite that part. When the inflammation has ceased, the penis should be bandaged from the pubes to the corona; over the glans the plaster is applied with the other end of the probe. This is done in order that the lower part may agglutinate, whilst the upper part heals without adhering."[134]

For this procedure, no cut is made around the base of the penis. The skin is cut around the edge of the glans, and this is pulled forward to cover it. Since the new covering of the glans is not exterior dermis, such as the case in the other procedure, but the raw underside of the dermis, a nonadherent plaster dressing is required around the glans and under the new prepuce to aid the growth of a new

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[132] Rubin, Jody P. "Celsus' Decircumcision Operation: Medical and Historical Implications." *Urology* 16, no. 1 (July 1980): 121-24.
[133] Ibid.
[134] Celsus, A. C. *De Medicina*, Book VII, Chapter 25. Accessed online via the Perseus Project. Tufts University.

epithelial surface; otherwise, the new prepuce could adhere itself to the glans, preventing any possibility of retraction.[135] Cold water effusions also help to ease the pain and swelling. For images depicting this procedure, see Figures 11a and 11b in the appendix on page 39.

The primary difficulty of both procedures, at least from the viewpoint of the surgeon, is preventing the skin from retracting without the use of sutures;[136]the pressure of the bandages could possibly have anchored the skin in its new position after the inflammation subsides.[137] Another possible complication would be if an erection is achieved while the penis is still healing – this would undoubtedly compromise the success of the procedure. Addressing this, Celsus recommends that patients "fast until nearly overcome by hunger" to prevent possible accidental erections. This statement implies, though, that virility was not impaired by this procedure, and that achieving erection could be possible even immediately after this procedure takes place. Because of the loose connection between the epidermis and the deep underlying structure of the penis, a relatively-easy and almost bloodless separation is possible theoretically, but this would require a skilled surgeon to prevent damaging the deep tissue. If the deep tissue is left unaffected, however, then achieving erection would be possible even directly after performing this procedure.

These two variations on decircumcision were carried out for cosmetic reasons, rather than to remedy life-threatening maladies. In essence, these procedures were performed to allow certain people to integrate into the larger society around them. While we know that this was performed in ancient Rome to make participating in sport and bath culture easier for certain men[138], and so a man could easily pass himself off as a "true Roman", this procedure saw a resurgence during the Second

[135] See footnote 26.
[136] Ibid.
[137] Ibid.
[138] Ibid.

World War for strikingly similar reasons.[139] Since circumcision was rarely practiced among European ethnic groups[140], apart from the Jews, a circumcised penis was a physical characteristic that could be used to identify and expose Jewish men in the community. We have some reports of doctors in Nazi-occupied Poland, especially Warsaw, performing surgery on Jewish men to restore the prepuce[141], in order that these men might blend into the society more easily and evade capture. Shlomo Perel's wartime memoir describes his own attempt at reconstructing his prepuce by sewing his penile shaft skin around the glans[142] – this attempt was unsuccessful, and most of the procedures performed by the Polish doctors were also unsuccessful in most cases. The motive behind these procedures was the same essentially in both antiquity as well as the modern day: that a circumcised penis was socially deviant and that by restoring the prepuce, a man might be able to pass himself off as a traditional member of the greater society in which he lives.

The writings of Celsus present to us a view of Roman surgery during the first century CE. Though the writings of Galen in the second century CE expand upon some of the topics presented by Celsus, *De Medicina* details the intricacies of many different kinds of ancient Roman surgical procedures involving many different areas of the body. To perform these sorts of surgeries, a Roman surgeon would have had to know much about the anatomy and healing processes of the human body. They would have had to know which instruments were better adapted for different surgical procedures, as well as ways to manage the patient during the procedures. Roman physicians possessed an remarkable amount of medical knowledge, thanks to the work of their Egyptian, Hellenic, and Hellenistic predecessors. Drawing on these rich sources, the Romans were able to

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139 Levin, S. "Letter: Circumcision and Uncircumcision." *South African Medical Journal* 50, no. 24 (June 5, 1976): 913.
140 Rubin, Jody P. "Celsus' Decircumcision Operation: Medical and Historical Implications." *Urology* 16, no. 1 (July 1980): 121-24.
141 Perel, Shlomo. *Europa, Europa.* New York: John Wiley and Sons, 1997. 256.
142 Ibid.

specialize their medicine into different fields, like gynecology, ophthalmology, and general surgery. These distinctions among different branches of medicine remain in place today – a testament to how much modern medicine has been influenced by the knowledge and surgical advances of the ancient Romans. Though the development of surgery as a practice was a group effort by humans in different civilizations across time, the ancient Romans have undoubtedly and unequivocally played an outsize role in contributing to our own knowledge of surgery and surgical techniques.

Appendix

Figure 1

Mandragora officinarum. By Tird, Kirsten. *Mandragora Officinarum*. Birhmann's Caudex: Caudiciforms. Retrieved from http://www.bihrmann.com/caudiforms/subs/man-aut-sub.asp.

Figure 2

Papaver somniferum. Retrieved from http://commons.wikimedia.org/wiki/File: Koeh-102.jpg.

Figure 3

Reproductions of Roman surgical knives from Pompeii and Herculaneum. Courtesy of Historical Collections & Services, Claude Moore Health Sciences Library, University of Virginia.

Figure 4

Reproductions of Roman spatula probes from Pompeii and Herculaneum. Courtesy of Historical Collections & Services, Claude Moore Health Sciences Library, University of Virginia.

Figure 5

Reproductions of Roman bloodletting cups from Pompeii and Herculaneum. Courtesy of Historical Collections & Services, Claude Moore Health Sciences Library, University of Virginia.

Figure 6

Reproductions of Roman bone levers from Pompeii and Herculaneum. Courtesy of Historical Collections & Services, Claude Moore Health Sciences Library, University of Virginia.

Figure 7

Reproduction of a Roman male catheter from Pompeii and Herculaneum. Courtesy of Historical Collections & Services, Claude Moore Health Sciences Library, University of Virginia.

Figure 8

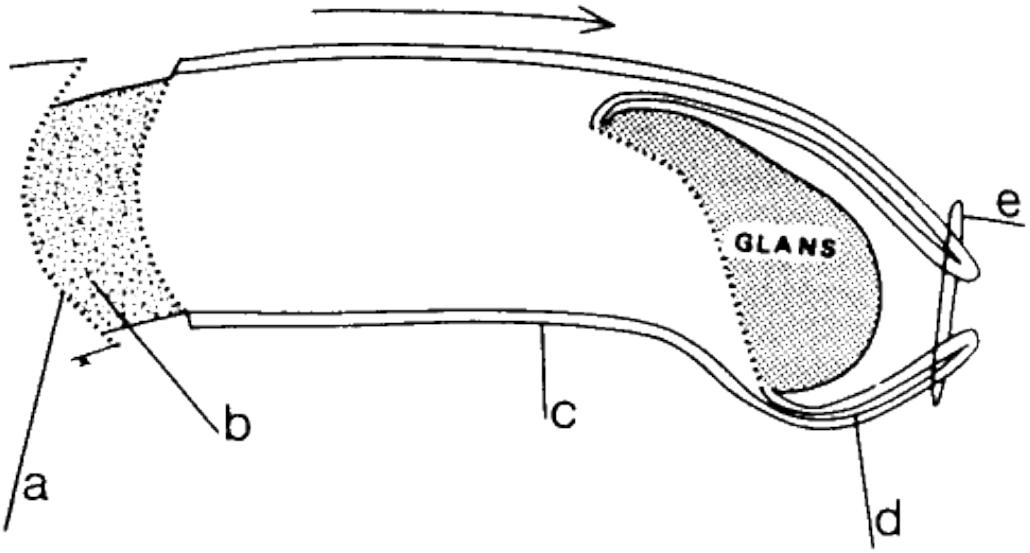
Reproduction of a Roman vaginal speculum from Pompeii and Herculaneum. Courtesy of Historical Collections & Services, Claude Moore Health Sciences Library, University of Virginia.

Figure 9

Ancient Roman needle with eyelet found at Ephesus, Asia, ca. 100 CE. Image found in: Kunzl, Ernst, and Franz Josef Hassel. *Medizinische Instrumente Aus Sepulkralfunden Der Römischen Kaiserzeit*. Köln: Rheinland, 1983. Image published in: Köckerling, F., D. Köckerling, and C. Lomas. "Cornelius Celsus—ancient Encyclopedist, Surgeon–scientist, or Master of Surgery?" *Langenbeck's Archive of Surgery* 398, no. 4 (April 2013): 609-16.

Figure 10

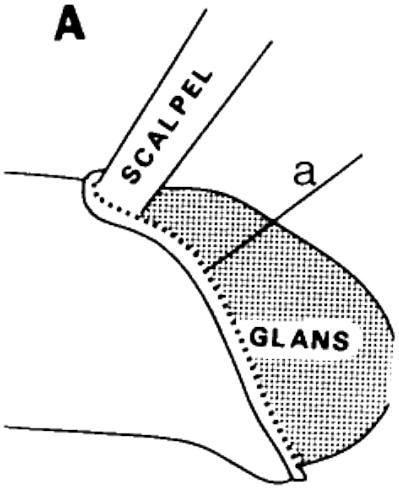
Operation for restoring a congenitally-deficient prepuce. Retrieved from Rubin, Jody P. "Celsus' Decircumcision Operation: Medical and Historical Implications." *Urology* 16, no. 1 (July 1980): 121-24.



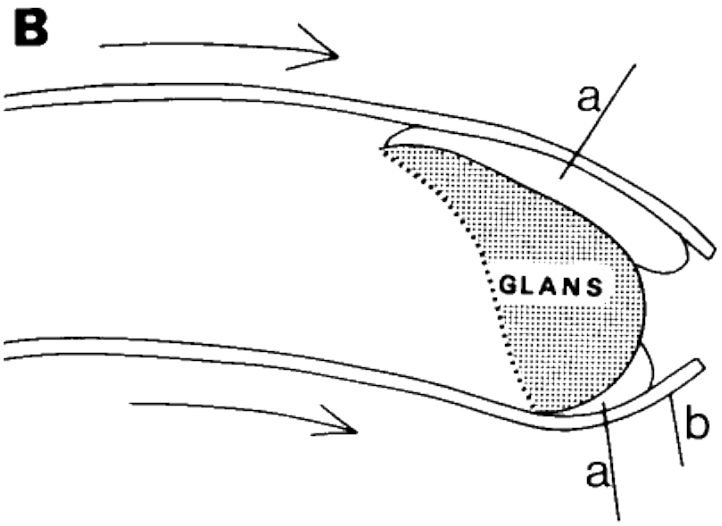
(a) line of surgical incision; (b) subcutaneous areolar tissue; (c) epidermis; (d) reconstructed prepuce; (e) tie

Figures 11a and 11b

Operation for restoring a circumcised prepuce. Retrieved from Rubin, Jody P. "Celsus' Decircumcision Operation: Medical and Historical Implications." *Urology* 16, no. 1 (July 1980): 121-24.



Skin is cut around the corona (a) of the glans and loosened along the shaft of the penis



Skin is pulled over glans, and after inflammation subsides, plaster (a) is packed between the new prepuce (b) and glans to prevent the raw undersurface of the stretched penile skin from adhering to the glans.

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