



Original Article

Gods and monsters: Greek mythology and Christian references in the neurosurgical lexicon

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Received : 16 January 2022
Accepted : 24 January 2022
Published : 25 February 2022

DOI
10.25259/SNI_70_2022

Quick Response Code:



ABSTRACT

Background: Myths and religion are belief systems centered around supernatural entities that attempt to explain the observed world and are of high importance to certain communities. The former is a collection of stories that belong to a cultural tradition and the latter are organized faiths that determine codes of ethics, rituals and philosophy. Deities or monstrous creatures in particular act as archetypes instructing an individual's conduct. References to them in Greek mythology and Christianity are frequently manifested in the modern neurosurgical vernacular.

Methods: A review of the medical literature was performed using the PubMed and MEDLINE bibliographic databases. Publications from 1875 to 2021 related to neurosurgery or neuroanatomy with the medical subject headings (MeSH) terms mythology, religion, Christianity and Catholicism were reviewed. References pertaining to supernatural beings were classified to either a deity or a monstrosity according to their conventional cultural context.

Results: Twelve narratives associated with neurosurgery were identified, nine relating to Greek mythology and three associated with the Christian-Catholic faith. Eight accounts concerned deities and the remaining with monstrous creatures.

Conclusion: This article explores the etymology of commonly utilized terms in daily neurosurgical practice in the context of mythology and religion. They reveal the ingenuity and creativity of early pioneers who strived to understand the brain.

Keywords: Christianity, Greek mythology, Neuroanatomy, Neurosurgery, Religion

INTRODUCTION

The word mythology is derived from the combination of the Greek words “study” (*logos*) and “myth” (*mûthos*), a symbolic narrative concerning the early history of a people or a natural phenomenon associated with religious belief. As a means to rationalize the inexplicable nature of observed events, myths have played important functions in providing continuity to a culture and creating archetypes for how one should behave. In particular, the tales of supernatural gods and monsters served as cautionary allegories for exemplary or reprehensible conduct. Greek

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mythology is considered one of the oldest and richest of all mythologies.^[17,22] With the Renaissance, a period in European history spanning from the 15th to 16th centuries, there was a fervent revival and development of ideas inherited from classic Greek culture. Andreas Vesalius (1514–1564), Leonardo da Vinci (1452–1519), and Heironymus Fabricius (1553–1619) were among the few Italian anatomists to perform human cadaveric brain studies under the watchful eye of the Roman Catholic church.^[1,3,23,34] It is, therefore, understandable that more than 90% of medical jargon have either Greek or Latin roots and the mythological-religious connotations of these rich cultures have found their way from antiquity into the modern neurosurgical vernacular.^[37] Previous studies have described the influence of Hellenistic mythology and Christianity in clinical neuroscience in broad contexts.^[17,22,24,27,40] This article reviews the origins of terms frequently utilized in daily neurosurgical practice that was influenced by these belief systems with regard to the deities and monsters that underpin them.

MATERIALS AND METHODS

A review of the medical literature was performed using the PubMed and MEDLINE bibliographic databases. Using the Boolean operator “AND,” publications related to neurosurgery or neuroanatomy with the medical subject headings terms *mythology*, *religion*, *Christianity*, and *Catholicism* were reviewed. The following search limits were: publication date from January 1875 to December 2021; reports concerning studies of humans; and reports in English, French or German. The citations from the included reports were also manually searched to find other studies that were not identified initially. The final search was performed on January 3, 2022.

RESULTS

The Gods

Poseidon’s steed and the horns of Ammon: The hippocampus

The hippocampal formation is phylogenetically one of the oldest structures of the brain serving critical functions in learning, episodic, and spatial memory. The structure was named by Julius Caesar Arantius (1529–1589) in the 16th century due its gross morphological resemblance to a seahorse, the small marine fish in the genus *hippocampus* (Greek: *hippos* for “horse” and *kampos* for “sea”).^[20,25] Their equine appearance, upright posture, and prehensile tail readily captured the imagination of the Renaissance anatomist [Figures 1a and b]. Poseidon, the Olympian god of the sea, is often depicted in a chariot pulled by hippocampi, mythical hybrid sea creatures with the head of a horse and the

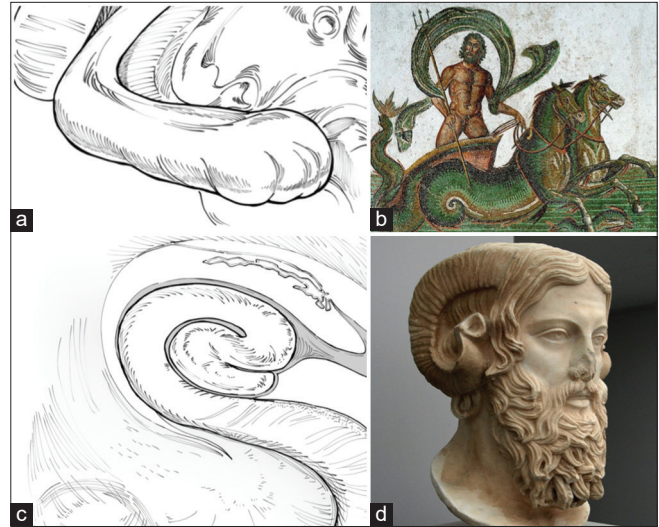


Figure 1: Schematic of the right hippocampus (a) and its mythological counterpart, the steed of Poseidon, Greek god of the sea (b), Roman mosaic, 3rd century, courtesy of the Sousse Museum, Tunisia. A coronal section schematic of the body of the hippocampus revealing the hippocampal formation and the cornu ammonis (c). Ammon, the amalgamation of the gods Zeus and Amun-Ra with his distinctive horns (d), marble sculpture, 2nd century, courtesy of Liebieghaus Skulpturensammlung, Frankfurt, Germany.

body of a dolphin.^[20,24,28] The cornu ammonis, the c-shaped structure that represents a ram’s horns in the coronal plane, is part of the hippocampal formation.^[36] In ancient Egypt the all-powerful sun god, Amun-Ra (or Ammon) was depicted with such horns (Latin: *cornu*). Recognizing the importance of Amun-Ra among his newly conquered subjects, Alexander the Great (356–323 BCE) culturally assimilated Zeus, the ruler of the Greek Olympian pantheon, with his Egyptian counterpart [Figures 1c and d]. The French anatomist, Jacques Benigne Winslow (1669–1760), a philhellene, was likely inspired by the in-folding substructure of the hippocampal formation to name it after the horns of this syncretic god in the 18th century.^[20,28]

Hermes and his winged helmet: The pterion

Hermes, the son of Zeus, is considered the herald of the Olympian gods and protector of travelers. He is classically presented wearing the *talaria*, winged sandals, and a winged *petasos*, a sun hat or helmet, that bestowed the power of swift travel [Figure 2]. Paul Broca (1824–1880) first coined term, pterion, the well-known neurosurgical landmark derived from the ancient Greek root *pteron* (wing).^[5] It is postulated that the neurologist envisioned that the wings of Hermes’s *petasos* were attached to this region of the cranium as depicted from ancient Greek or Roman artwork. The pterion is the intersection between the frontal, temporal, sphenoid and parietal bones. In modern neurosurgery, the



Figure 2: Schematic of the established neurosurgical landmark, the pterion (a) and Broca's association with Hermes's, the messenger god, wings of flight attached to his helmet (b), photograph by the author PW, marble sculpture, 18th century, Louvre Museum, Paris, France or directly from his head at this region (c), photograph by the author PW, marble sculpture, 19th century, courtesy of the Musée d'Orsay, Paris, France.

pterional craniotomy is generally considered a fundamental workhorse approach for neurosurgeons to gain wide access to the skull base.

Atlas the titan and the C1 vertebra

Atlas was a Titan, an older generation of gods that preceded the Olympians, condemned to hold up the sky for eternity on his shoulders according to Hesiod's *Theogony*. His punishment was a result of his defeat in the War of the Titans, the Titanomachy, that was fought against the Olympian gods for dominion of the universe. The first vertebra of the cervical spine takes its name from the Titan for its anatomical location supporting the weight of the skull.^[16,17,24] It is commonly misconstrued today in the interpretation of Renaissance art that Atlas is portrayed as lifting Earth as a terrestrial globe [Figure 3]. However, before the discoveries of Nicolaus Copernicus, ancient Greeks such as Plato believed that the Earth was at the center of the universe surrounded by celestial spheres which were the original object of Atlas's burden.

The thalamus: Resting place of immortals

Aelius Galenus (129–216 CE) or Claudius Galenus, commonly known as Galen, was the first to introduce the term “thalamus,” derived from the Greek word *thalamos* for “sleeping chambers” in the 2nd century CE [Figures 4a and b].^[12,27] To reinforce its namesake, the posterior rounded eminence of the thalamus is called the pulvinar which comes from the Latin *pulvinus*, “cushion,” by the German anatomist Karl Friedrich Burdach (1776–1847). He described how the two thalami resembled the cushioned armrests of a chair when viewed posteriorly. In ancient Rome, the *pulvinus*, a cushioned empty throne meant for the gods, was a common fixture in religious ceremonies and Roman villas [Figure 4c].^[41] The nucleus endymialis,



Figure 3: The *Farnese Atlas* holding up the celestial globe (marble sculpture, 2nd century, courtesy of the Museo Archeologico Nazionale, Naples, Italy).

otherwise known as the nucleus reuniens, belongs to the median thalamic nuclei that borders the interthalamic adhesion. The nucleus plays an important role in regulating spatial working memory and emotional learning, behaviors enhanced with restful sleep.^[12,14] Its name is reminiscent of the youth of Greek legend, Endymion, who was offered by Zeus anything he might desire. Endymion chose immortality and everlasting youth in eternal slumber within the grottoes of Mount Latmos [Figure 4d].^[25] In recent years, the thalamus, in particular the reticular nucleus, has been identified to be a key player in regulating sleep.^[12,42] Although sleep may appear outwardly as an uniform behavior, different neural circuits of the sleeping brain exhibit distinct activity patterns, known as local sleep, during periods of non-rapid eye movement. The reticular nucleus through its diverse thalamo-cortical connections serves to coordinate the activities of these circuits in order to protect their synaptic wiring and plasticity.^[42] Galen would never have known the

far-reaching associative functions of the thalamus when he first named this structure.

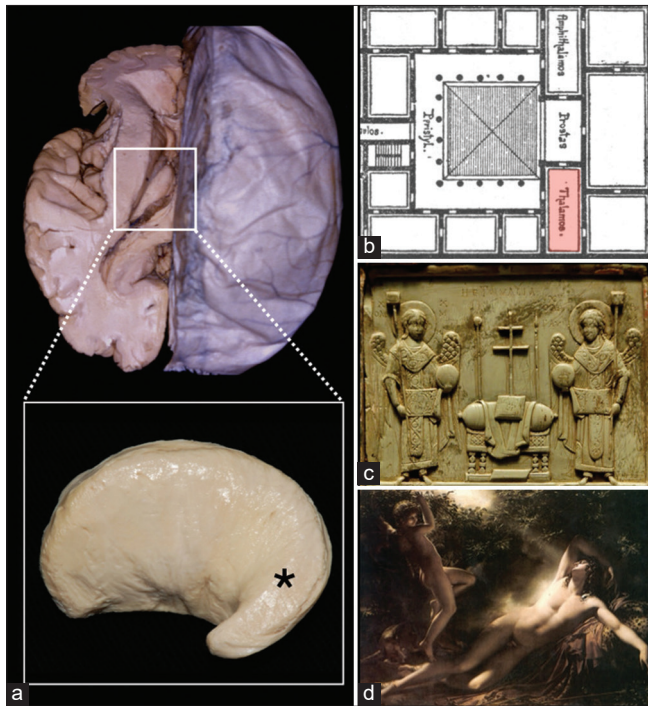


Figure 4: The thalamus, “sleeping chamber”, within the central core, and the pulvinar, “cushion” (*, inset, a). The architectural plans of a typical Roman villa following Vitruvian design indicating the location of the *thalamos*, the master bedroom (b), Vitruvius Pollio, *De Architectura*, 1st century BCE. The cushioned empty throne *pulvinus*, a ritualistic object often used in religious ceremonies. Note the inscription *Hetoimasia*, Latin for “prepared throne” for the second coming of Christ (c), Ivory icon, 10th century, courtesy of the Louvre Museum, Paris, France. The final sleeping place of Endymion within Mount Latmos (d), *The Sleep of Endymion*, oil on canvas by Anne-Louis Girodet de Roucy-Triosson, 18th century, courtesy of the Louvre Museum, Paris, France.

Golgotha and skull hill: The calvaria

The *calvaria* was originally described as the “upper part of the head” enclosing the brain. Golgotha (Aramaic for “place of the skull”), also called Calvary in its anglicized form, is the name for the hill of execution situated outside ancient Jerusalem’s walls and the site of Jesus’s crucifixion. The spot is mentioned in all four of the canonical Gospels, for example, in Matthew 23:33 “And when they were come unto place call Golgotha, that is to say a place of a skull.” As an execution site, it would have been strewn with skulls, but others have attributed the hill’s namesake for its topographical shape upon which the Church of the Holy Sepulcher is now located [Figure 5].^[39] Calvaria is the feminine singular normative form of the noun with the plural form being “calvariae”.^[11] A common mistake made in the medical literature is the use of the term “calvarium” as a singular noun.^[39]

The petrous bone, claustrum, fornix, and the thalamus: Cerebral vitruvian architecture

Marcus Vitruvius Pollo (80–15 BCE), commonly known as Vitruvius, was a Roman architect who described in his seminal work *De Architectura*, the importance of viewing the human body as the principal source of proportion for constructing places of worship.^[6] His treatise was rediscovered during the Renaissance with famous architects such as Filippo Brunelleschi, creator of the dome of the Florence Cathedral, who incorporated Vitruvian philosophy into church design. In parallel with advances in this field, neuroanatomy was undergoing a similar revival and it is believed that architectural metaphors with religious connotations were used to identify certain neuroanatomical structures.

The petrous, an important neurosurgical landmark, is a pyramid-shaped portion of the temporal bone located at the skull base between the sphenoid and occipital bones. Petrous



Figure 5: Calvary or Golgotha “Skull Hill”, the believed location of the crucifixion of Jesus as seen in 1901 from the northern walls of Jerusalem’s old city (a), courtesy of The Garden Tomb (Jerusalem) Association. A current day photograph revealing a section of the hill topographically resembling the features of a skull (b), photograph by the author PW. Skull Hill was likely strewn with the skulls of the executed (c), *The Crucifixion with Saint Jerome and Saint Francis*, tempera on wood by Pesellino, 15th century, courtesy of the National Gallery of Art, Washington, D.C., USA.

is derived from the Greek word *pétra* meaning “stone” which is also the etymological root for the name Peter (or Pieter, Pierre). It was also the name Jesus bestowed to his apostle Simon, subsequently known as Saint Peter, one of the first leaders of the early Church. Although it is unclear who or why this skull base landmark was named the petrous bone, an intriguing dialogue between Jesus and Simon exists in Matthew 16:13-19: “Blessed are you, Simon son of Jonah, for this was not revealed to you by flesh and blood, but by my Father in heaven. And I tell you that you are Cephas (Peter) (*Petros*), and on this rock (*petra*) I will build my church, and the gates of Hades will not overcome it. I will give you the keys of the kingdom of heaven.” The association between this ideology and the naming of the petrous bone as a literal foundation on which the brain rests is compelling.

The English term cloister (Latin: *claustrum* for “enclosure”) represents a covered walkway or gallery running along the walls of a quadrangular church space. Cloisters effectively separated those looking to lead an ascetic monastic life from the distractions of the city. Anatomically, the claustrum, a thin layer of grey matter lying between the extreme and external capsules, is situated within the equally aptly named insular lobe. Its function has yet to be understood, but it has been proposed to be involved in permitting widespread cross-modal transmission of perceptual, cognitive, and motor information contributing to synchronized processing.^[9]

The fornix (Latin: *fornix* for “arch” or “vault”) is a C-shaped structure forming part of the limbic lobe. It is the major efferent pathway from the hippocampus to the mammillary bodies originating from the mesial temporal lobe arching around the thalamus to the diencephalon and basal forebrain.^[35] Its function is associated with episodic memory recall and cognition. Galen first described its shape and its namesake in his treatise *On the Usefulness of the Parts of the Body, De Usu Partium*, in the 2nd century: “The part of the encephalon above the common cavity [the third ventricle], like the roof of a house, is rounded up to look like a hollow sphere and seems not without good reason to have been called a little vault or arch [fornix]. Indeed, just as those [vaults and arches] are more suitable than any other shape for carrying the load resting upon them, so too this vault-shaped body [the fornix] holds up without distress all that portion of the encephalon that lies above it.”^[27] Such vaulted ceilings are common design motifs in cathedrals and adds to speculation that early anatomists sanctified the brain in the spirit of Vitruvius [Figure 6].

The three crowns: Coronal suture, corona radiata and Saint Stephen

The crown (Latin: *corona* or ancient Greek: *korone*) is a traditional head adornment typically worn by monarchs symbolizing their power and dignity. In European

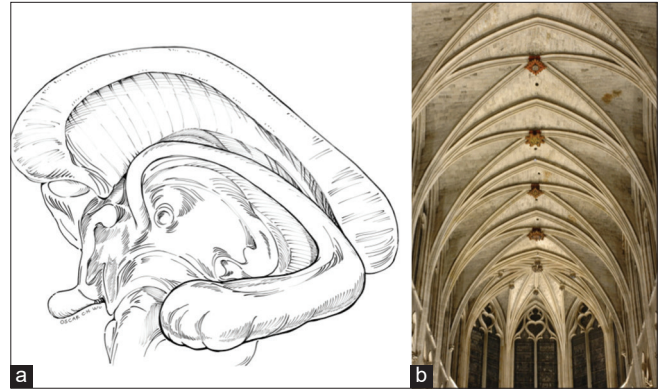


Figure 6: A schematic demonstrating the arch-shaped structure of the fornix and its association with the limbic lobe (a). The vaulted ceiling displaying the fornixes of the Gothic church Saint-Séverin, Paris, France (b), photograph courtesy of Roman Bonnefoy.

Christendom, the royal crown is placed on the new monarch’s head by an ecclesiastical official in a coronation ceremony. The coronal suture and the *corona radiata* were most likely coined by early Greek anatomists seeking inspiration from Helios, the god of the sun, who was often portrayed adorning a crown embellished with sun rays when viewed on the frontal plane [Figure 7a]. Subcortical white fiber dissection studies readily demonstrate why the projection fibers that fan from the internal capsule to the cortex were named the *corona radiata* [Figure 7b].

First systematically documented by Broca in *Sur la topographie crânio-cérébrale* in the 1870s, craniometric points are superficial landmarks that aid with the localization of important intracranial structures.^[32] The *Stephanion* is a point where the coronal suture intersects with the superior temporal line, lying 8cm lateral to the bregma. Intracranially, it indicates the meeting point of the inferior frontal sulcus and the pre-central sulcus.^[32] The name Stephen is derived from the Greek word *stéphanos* meaning “crown” and was popularized after Saint Stephen was venerated as the first martyr of Christianity. According to the Acts of the Apostles, Saint Stephen, a deacon in the early church of Jerusalem was stoned to death by the Jewish council after he condemned them for murdering Jesus. In religious art Saint Stephen, the patron saint of stonemasons and headaches, is frequently illustrated wearing a crown, which would have rested firmly on the *Stephanion*, as well as rocks on his head intimating that the cause of his death was severe traumatic brain injury [Figures 7c and d].

From apoplexy to being stricken by god’s hand

Before the modern utilization of the word “stroke” as a diagnosis, apoplexy (Greek: *apoplexia* for “to be struck down with violence”) was the predominant term for millennia until the early 20th century.^[8] The term was originally coined by Hippocrates of Cos (460–370 BCE) who described how patients “suddenly

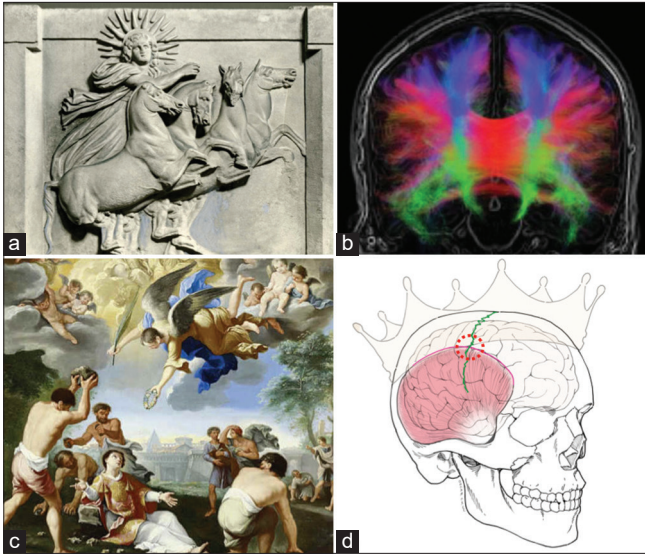


Figure 7: Helios, the sun god of Greco-Roman mythology, riding his chariot across the sky adorned with his *corona* “crown” (a), marble relief, 4th century BCE, courtesy of the Pergamon Museum, Berlin, Germany. The *corona radiata* known today, a term used to describe the numerous thalamo-cortical projection fibers running through the internal capsule (b), coronal view of magnetic resonance imaging tractography. Saint Stephen, the first martyr of Christendom, being bestowed a crown as he is stoned to death (c), *The Stoning of Saint Stephan*, oil on canvas by Luigi Garzi, 18th century. The *Stephanion* (red encircled area), an important craniometric point representing the intersection of the coronal suture (green) and the superior temporal line. The landmark indicates the location of the intersection between the inferior frontal sulcus and the pre-central sulcus (d).

fell, without consciousness of motion, retaining pulse and respiration.”^[27] The first recorded use of “stroke” in the English literature was in 1599 when the sudden onset of symptoms were attributed to “the striking by God’s hand,” “the stroke of God” or the “stroke of justice.”^[30] Until the late 17th century when the number of autopsies being performed increased and cerebrovascular causes were recognized, physicians were convinced that stroke was a sign of divine retribution.^[30]

The Monsters

A tale of jealousy and piety in the meninges: The arachnoid and pia mater

Herophilus of Chalcedon (335–280 BCE), known as the father of anatomy, described the arachnoid trabeculae as reminiscent of a spider’s web and bestowed the name “arachnoid” from the Greek word *arachne* for “spider” for this layer of the meninges.^[29] Ovid’s poem, *The Metamorphoses*, recounts the tale of Arachne, a maiden who from humble beginnings rose to fame for her weaving talents. Athena, the Olympian goddess of handicrafts and warfare, was jealous of

Arachne’s reputation and proposed a weaving contest. They each wove tapestries depicting themes in their favor, Arachne’s portrayed the mistreatment of mortals by the gods, while Athena’s showed images of mortals punished for challenging the gods. When completed Athena, finding no fault with Arachne’s masterpiece, angrily destroyed both her tapestry and loom causing her to commit suicide out of shame. Athena subsequently revived Arachne and transformed her into a spider cursing her to spin her webs for eternity [Figure 8a].^[33]

Use of the Latin word *mater*, denoting “mother,” to describe the meninges was derived from the Arab term *umm al-dimāgh* meaning “mother of the brain” and was introduced by the medieval Persian physician Haly Abbas (930–994).^[18] Originally the meninges were described as having two layers in Arabic, the “hard mother” (*umm al-galidah*) and the “thin mother” (*umm al-raqiqah*). This was subsequently transcribed by Christian monks to *dura mater* and *pia mater* respectively with the word *pia* meaning pious or beloved.^[18,27] It was likely that Abbas’s descriptions of how the pia mater faithfully followed the contours of the cortex inspired the monks to substitute a literal translation that should have been *tenuē* (“thin”) to one with a religious meaning.^[18]

The tragedy of Medusa

The neuroradiological term *caput Medusa* (Latin for “head of Medusa”) is used to describe cerebral developmental venous anomalies that comprise the commonest form of vascular malformations.^[17,19] As a non-pathological variant of venous drainage, they constitute a confluence of radially oriented veins draining into a single dilated venous channel. Their unique appearance on catheter angiography and magnetic resonance imaging readily alludes to the Greek myth by Ovid in *The Metamorphoses* [Figures 8b and c]. Medusa was originally a beautiful priestess serving in Athena’s temple. She was raped by Poseidon and because the atrocity took place in a holy temple Athena punished the victim in line with classic Greek tragedies. Medusa was transformed into a hideous gorgon with snakes that replaced her hair and was cursed so that anyone who laid eyes upon her face would turn to stone.^[17,19]

Asterion: The craniometric landmark and the minotaur

The *asterion* is the junction of the lambdoid, occipito-mastoid, and parietal-mastoid sutures and is an important neurosurgical landmark for lateral approaches to the posterior fossa. It is historically considered a craniometric landmark for the junction between the transverse and sigmoid dural venous sinuses [Figure 8d]. *Asterion* is derived from the ancient Greek word *aster* meaning “the starry one” and the reasons for this name remain unclear. *Asterion* refers to several figures in Greek mythology one of which was the river god in the region of Argolis who sided with two river

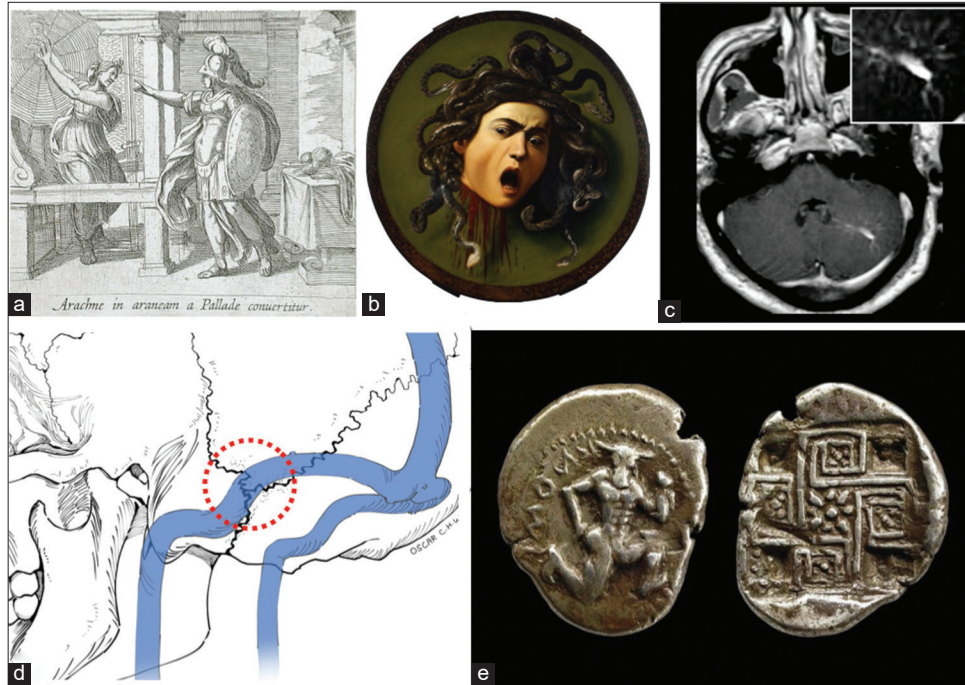


Figure 8: The monsters gallery. Arachne at the moment of being transformed into a spider by the jealous Athena (a), *Athena Changing Arachne into a Spider*, plate by Antonio Tempesta, 17th century. The classic portrayal of Medusa at the moment of her beheading (b), *Medusa*, oil on canvas by Caravaggio, 16th century, courtesy of the Uffizi, Florence, Italy. A magnetic resonance imaging scan revealing an incidental caput medusa of the left cerebellum (c), axial, T1-weight gadolinium contrast-enhanced sequence. The *asterion*, a craniometric landmark historically used to indicate the location of the sigmoid-transverse dural venous sinus junction (asterion, red-encircled area, d). A silver coin discovered at the ruins of Knossos, Crete, revealing *Asterion* “the starry one,” the name of the ancient city state’s legendary minotaur, and his dwelling at the center of the labyrinth (e), 5th century BCE.

deities to award the territories they irrigated to Hera instead of Poseidon. However, this explanation fails to explain why the confluence of the three sutures would be named after Asterion alone. Perhaps a more compelling postulation was that *Asterion* referred to the birth name of the infamous minotaur of Crete. The chimeric beast, with a bull’s head and body of a man, was imprisoned at the center of a labyrinth by his father and subsequently slaughtered by Theseus. 5th century BCE coins discovered at the ruins of Knossos, Crete show a labyrinth with a bull’s head or a star at its center, in tribute to the minotaur’s name and as testament to the island state’s pride in their local legend [Figure 8e].^[2] The junction of these meandering sutures could have been named after the minotaur’s final resting place.

Pan and Syrinx’s vengeance

Pan, the son of Hermes, is the lustful deity of the wild and is generally depicted in the male form with the hindquarters and legs of a goat. The majority of artistic representations include a tuft of hair arising from the lumbosacral spine meant to resemble a faun’s tail. One of Pan’s lasting contributions to neurosurgery is his memorable features. For clinicians, the presence of lumbar hypertrichosis coupled with pes cavus deformities would

suggest the presence of spinal dysraphism^[15,17,26,43] [Figures 9a and b]. Another of Pan’s legacies in medical terminology is the consequence of his aggressive overtures to conquest the beautiful nymph Syrinx. According to Ovid’s *The Metamorphoses*, the chaste nymph declined his amorous advances and panic-stricken fled to the banks of the river Lykaion. In a desperate bid to escape, Syrinx was transformed by his sisters into a bundle of riverside reeds. On her disappearance, the sullen Pan became enraptured by a melancholic melody as a breeze blew across the hollow reeds. He proceeded to cut down several, bound them together and created a panpipe which he is often portrayed playing [Figure 9c].^[15,43]

Today, the syringe is named in memory of Syrinx’s tale for its hollow tubular structure. In neurosurgery, the diagnosis of a syrinx or syringomyelia refers to the development of a fluid-filled cavity within the spinal cord [Figure 9d].^[15,17,24,26] Much like Syrinx’s metamorphosis, the pathogenesis of syringomyelia remains an enigma, although it is believed to result from a complex interplay of cerebrospinal fluid flow, pressure, and its pathways.^[21] Perhaps in the end Syrinx did exact her revenge on Pan, as spinal dysraphism is widely considered a primary cause for syringomyelia. Among its numerous neurological symptoms, erectile dysfunction may

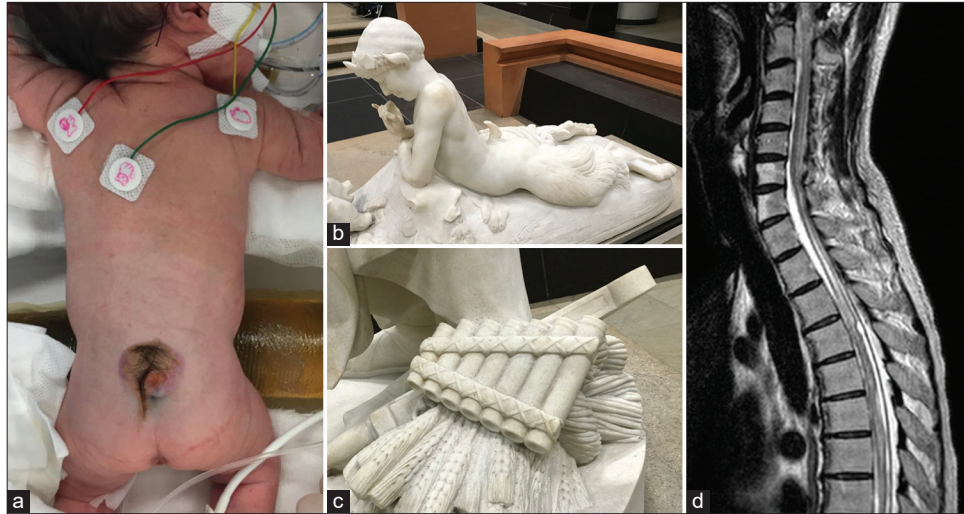


Figure 9: Clinical photograph of a neonate with lumbar hypertrichosis and spina bifida aperta (a). Pan demonstrating his faun tail and clubbed feet (b), photograph by the author PW, marble sculpture 19th century, Musée d'Orsay, Paris, France. Syrinx's ultimate fate as a panpipe often seen by Pan's side (c), photograph by the author PW, marble sculpture 19th century, Musée d'Orsay, Paris, France. Post traumatic thoracolumbar syringomyelia (d), sagittal T2-weighted sequence magnetic resonance imaging.

have been the most distressing and befitting punishment for the lascivious creature.

DISCUSSION

Neuroscience was borne from the great ages of human scientific discovery namely, Greek antiquity and the Italian Renaissance.^[3,23] In response to the prevailing cultural belief systems of these two eras, it was natural that ancient Greek mythological and Christian symbolism transcended through time into the modern medical lexicon.^[3,17,24] Cephalocentrism, the philosophical school of thought concerning the brain as the command center of the body, was first introduced by Hippocrates. He not only described the brain as the seat of consciousness, emotions, behavior, and judgment, but also observed that its injury could result in paralysis, seizures or death.^[10] It was until the 3rd century when systematic human cadaveric dissections were first documented in Alexandria by the ancient Greek physicians Herophilus (335–280 BCE) and Erasistratus of Ceos (304–250 BCE).^[29,38] Such endeavors were subsequently revived in the 16th century largely due to the contributions of Vesalius in his quest to subvert Galen's centuries-old dogmatic anatomical suppositions endorsed by the Christian church.^[13] The brain was an especially difficult organ to dissect in the absence of tissue fixation techniques, but Vesalius and his contemporaries persisted in their empirical approach to learning through direct observation.^[1,3,23] This spirit of scientific inquiry, where conclusions to questions of the unknown often raises more questions is in contrast with man's natural desire for a definitive answer. One of the fundamental roles of organized belief systems is to bridge this chasm. Pioneers of neuroanatomy were likely inspired by this predicament by referencing certain structures

to these ideologies as testament to the humbling limitations of science and their perpetual quest for knowledge.

One of the limitations of this study was that only English language references, or their translations, were consulted with most being secondary sources. Reviewing the Greek or Latin primary source materials would have enriched our descriptions, but locating and accessing them as well as translating the original text proved challenging. Second, the decision was made to describe only commonly used neurosurgical terms and archaic vocabulary seldom adopted in clinical practice was excluded. For example the hippocampal commissure and the crura of the fornix was once referred anatomically as the *psalterium* of King David, a harp-shaped instrument.^[25] In addition, there is wealth of cultural references regarding neurosurgery that were excluded as they were beyond our focus on lexical associations such as the birth of Athena from within the head of Zeus that was thought to be the first craniotomy described in literature.^[4] This review was only concerned with Greek and Christian influences, but one should not underestimate the contributions of other ancient cultures, such as Egyptian, Hindu, and Chinese, to contemporary clinical neuroscience.^[22,31] Finally, establishing an association between traditional folklore and neurosurgical terminology requires a degree of conjecture, but there lies a kernel of truth at the heart of every myth.

CONCLUSION

It was the ancient Greeks that first espoused the philosophical school of cephalocentric thought. This may be why the clinical neurosciences are enriched with probably more mythological references than any other medical specialty.

This comprehensive exploration of the Greek mythical and Christian roots of neurosurgical terminology serves as a reminder of the evolution of neuroscience and the importance of symbolism in the history of humankind.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Abbott A. The man who bared the brain. *Nature* 2015;521:160.
- Bazopoulou-Kyrkanidou E. Chimeric creatures in Greek mythology and reflections in science. *Am J Med Genet* 2001;100:66-80.
- Bem Junior LS, Lemos NB, de Lima LF, Dias AJ, Neto OD, de Lira CC, et al. The anatomy of the brain learned over the centuries. *Surg Neurol Int* 2021;12:319.
- Brasiliense LB, Safavi-Abbasi S, Crawford NR, Spetzler RF, Theodore N. The legacy of hephaestus: The first craniotomy. *Neurosurgery* 2010;67:881-4; discussion 4.
- Broca P. Instructions craniologiques et craniometriques. *Mem Soc Anthropol Paris* 1875;2:1-203.
- Camerota F. A Scientific Concept of Beauty in Architecture: Vitruvius Meets Descartes, Galileo, and Newton. In: Gerbino A, editor. *Geometrical Objects: Architecture and the Mathematical Sciences 1400-1800*. Vol. 38. Switzerland: Springer, Cham; 2014.
- Clarke E. Apoplexy in the hippocratic writings. *Bull Hist Med* 1963;37:301-14.
- Coupland AP, Thapar A, Qureshi MI, Jenkins H, Davies AH. The definition of stroke. *J R Soc Med* 2017;110:9-12.
- Crick FC, Koch C. What is the function of the claustrum? *Philos Trans R Soc Lond B Biol Sci* 2005;360:1271-9.
- Crivellato E, Ribatti D. Soul, mind, brain: Greek philosophy and the birth of neuroscience. *Brain Res Bull* 2007;71:327-36.
- Diab M. Errors of language in orthopaedics. *J Bone Joint Surg Am* 2001;83:1269-181.
- García-Cabezas M, Pérez-Santos I, Cavada C. The Epic of the Thalamus in Anatomical Language. *Front Neuroanat* 2021;15:744095.
- Ghosh SK. Human cadaveric dissection: A historical account from ancient Greece to the modern era. *Anat Cell Biol* 2015;48:153-69.
- Griffin AL. Role of the thalamic nucleus reuniens in mediating interactions between the hippocampus and medial prefrontal cortex during spatial working memory. *Front Syst Neurosci* 2015;9:29.
- Hakan T. Neurosurgery and a small section from the Greek myth: The God Pan and Syrinx. *Childs Nerv Syst* 2009;25:1527-9.
- Hamilton E. *Mythology*. New York: Little, Brown and Company; 1942.
- Karakis I. Neuroscience and Greek mythology. *J Hist Neurosci* 2019;28:1-22.
- Kothari M, Goel A. Maternalizing the meninges: A pregnant Arabic legacy. *Neurol India* 2006;54:345-6.
- Lee KS, Lin CL, Chuang CL, Hwang SL, Howng SL, Lieu AS. Odyssey between the constellations and neuromedicine. *Surg Neurol* 2006;65:99-101.
- Lewis FT. The significance of the term hippocampus. *J Comp Neurol* 1923;35:213-30.
- Mallucci C, Brodbelt A. The enigma of syringomyelia. *Br J Neurosurg* 2007;21:423-4.
- Nanda A, Filis A, Kalakoti P. Mythological and prehistorical origins of neurosurgery. *World Neurosurg* 2016;89:568-73.
- Nanda A, Khan IS, Apuzzo ML. Renaissance neurosurgery: Italy's iconic contributions. *World Neurosurg* 2016;87:647-55.
- Okten AI. Mythology and neurosurgery. *World Neurosurg* 2016;90:315-21.
- Orly R, Haines DE. Cerebral mythology: A skull stuffed with gods. *J Hist Neurosci* 1998;7:81-3.
- Palacios-Sanchez L, Botero-Meneses JS, Velez-Florez MC. Pan, syrinx and syringomyelia. *Arq Neuropsiquiatr* 2017;75:890-1.
- Paluzzi A, Fernandez-Miranda J, Torrenti M, Gardner P. Retracing the etymology of terms in neuroanatomy. *Clin Anat* 2012;25:1005-14.
- Pearce JM. Ammon's horn and the hippocampus. *J Neurol Neurosurg Psychiatry* 2001;71:351.
- Pearce JM. The neuroanatomy of herophilus. *Eur Neurol* 2013;69:292-5.
- Pound P, Bury M, Ebrahim S. From apoplexy to stroke. *Age Ageing* 1997;26:331-7.
- ReFaey K, Quinones GC, Clifton W, Tripathi S, Quiñones-Hinojosa A. The eye of horus: The connection between art, medicine, and mythology in ancient Egypt. *Cureus* 2019;11:e4731.
- Ribas GC, Yasuda A, Ribas EC, Nishikuni K, Rodrigues AJ. Surgical anatomy of microneurosurgical sulcal key points. *Neurosurgery* 2006;59 4 Suppl 2:ONS177-210; discussion ONS-1.
- Sanan A, van Loveren HR. The arachnid and the myth of Arachne. *Neurosurgery* 1999;45:152-5; discussion 5-7.
- Scatliff JH, Clark JK. How the brain got its names and numbers. *AJNR Am J Neuroradiol* 1992;13:241-8.
- Senova S, Fomenko A, Gondard E, Lozano AM. Anatomy and function of the fornix in the context of its potential as a therapeutic target. *J Neurol Neurosurg Psychiatry* 2020;91:547-59.
- Sommer W. Disease of Ammon's horn as an etiological element of epilepsy. *Arch Psychiatr* 1880;10:631-75.
- Soutis M. Ancient Greek terminology in pediatric surgery: About the word meaning. *J Pediatr Surg* 2006;41:1302-8.
- Stefanou MI. The footprints of neuroscience in Alexandria during the 3rd-century BC: Herophilus and erasistratus. *J Med Biogr* 2020;28:186-94.

39. Tubbs RS, Loukas M, Shoja MM, Apaydin N, Salter EG, Oakes WJ. The intriguing history of the human calvaria: sinister and religious. *Childs Nerv Syst* 2008;24:417-22.
40. Tubbs RS, Loukas M, Shoja MM, Cohen-Gadol AA, Wellons JC, Oakes WJ. Roots of neuroanatomy, neurology, and neurosurgery as found in the Bible and Talmud. *Neurosurgery* 2008;63:156-62; discussion 62-3.
41. Turliuc D, Turliuc Ş, Cucu A, Dumitrescu GF, Cărăuleanu A, Buzdugă C, *et al.* A review of analogies between some neuroanatomical terms and roman household objects. *Ann Anat* 2016;204:127-33.
42. Vantomme G, Osorio-Forero A, Lüthi A, Fernandez LMJ. regulation of local sleep by the thalamic reticular nucleus. *Front Neurosci* 2019;13:576.
43. Williams GP, Leavitt L. Essay: How pan got his tail: The fusion of medicine, art, and myth. *Neurology* 2004;62:519-22.

How to cite this article: Woo PYM, Au D, Ko NKM, Wu O, Chan EKY, Cheng KKF, *et al.* Gods and monsters: Greek mythology and Christian references in the neurosurgical lexicon. *Surg Neurol Int* 2022;13:67.