Original Article

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

Peter Y. M. Woo¹, Danise Au¹, Natalie M. W. Ko¹, Oscar Wu¹, Emily K. Y. Chan², Kevin K. F. Cheng³, Alain K. S. Wong¹, Ramez Wadie Kirollos⁴, Guilherme Ribas⁵, Kwong-Yau Chan¹

¹Department of Neurosurgery, Kwong Wah Hospital, Hong Kong, ²Division of Neurosurgery, Department of Surgery, Prince of Wales Hospital, Hong Kong, ³Division of Neurosurgery, Department of Surgery, Queen Mary Hospital, Hong Kong, ⁴Department of Neurosurgery, National Neuroscience Institute, Singapore, ⁵Department of Neurosurgery, Albert Einstein Hospital, Sao Paulo, Brazil.

E-mail: *Peter Y. M. Woo - wym307@ha.org.hk; Danise Au - danisem.au@gmail.com; Natalie M. W. Ko - kmw805@ha.org.hk; Oscar Wu - 1155079436@link.cuhk.edu.hk; Emily K. Y. Chan - emilychan@surgery.cuhk.edu.hk; Kevin K. F. Cheng - ckkf414@ha.org.hk; Alain K. S. Wong - wongksa@ha.org.hk; Ramez Wadie Kirollos - kirollos77@hotmail.com; Guilherme Ribas - guilherme@ribas.med.br; Kwong-Yau Chan - chanky03@ha.org.hk

INTRODUCTION

The word mythology is derived from the combination of the Greek words "study" (logos) and "myth" (muthos), 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
mythology is considered one of the oldest and richest of all mythologies.\cite{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.\cite{11,3,23,34} 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.\cite{37}

Previous studies have described the influence of Hellenistic mythology and Christianity in clinical neuroscience in broad contexts.\cite{17,22,24,27,40} This article reviews the origins of terms frequently utilized in daily neurological 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 to its gross morphological resemblance to a seahorse, the small marine fish in the genus hippocampus (Greek: hippos for “horse” and kamps for “sea”).\cite{20,23}

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 body of a dolphin.\cite{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.\cite{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.\cite{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).\cite{3} 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
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. 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]. 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]. The nucleus endymalis, 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. 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]. In recent years, the thalamus, in particular the reticular nucleus, has been identified to be a key player in regulating sleep. 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. Galen would never have known the...
far-reaching associative functions of the thalamus when he first named this structure.

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 pleural 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
The term was originally coined by Hippocrates meaning “crown” and was popularized after for “arch” or “vault”). It is a C-shaped structure of the encephalon above the common cavity (the third ventricle), which would have rested firmly on the foundation on which the brain rests is compelling. The association between this ideology and the naming of the petrous bone as a literal foundation on which the brain 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 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-model transmission of perceptual, cognitive, and motor information contributing to synchronized processing.

The fornix (Latin: fornic 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. 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.” 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: koréne) is a traditional head adornment typically worn by monarchs symbolizing their power and dignity. In European 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. 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. 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. The term was originally coined by Hippocrates of Cos (460–370 BCE) who described how patients “suddenly
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].

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-raaqiqah). 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 tenue ("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
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]. 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 conquer 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
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. 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. 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. 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). 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. 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. 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 Kind David, a harp-shaped instrument. 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. 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. 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

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