NE OF THE MOST well known and widely accepted works on neurosurgical medicine, both technique and management, was written in Persia between AD 900 and 1200. This period of enlightenment followed that of the Greek civilization and the era of Hippocrates and Galen. Galen’s neuroanatomical observations and pathophysiological correlations served as pillars on which Arabic knowledge was built.

Three of the most significant and influential medieval scholars responsible for the advances in medical knowledge during this era were Avicenna, Abulcasis, and Rhazes. These physicians thrived between the 10th and 12th century, and have been revered into the modern era for their consolidation, interpretations, and preservation of medical literature of the Greek and Roman periods. Although there were other medical philosophers during the same era, these three were among the few that contributed to the advancement of neurological and general surgical practices in an environment of religious constraints.

Abu Ali al-Husayn ibn Abd Allah ibn Sina (Avicenna)

Avicenna (AD 980–1037), a Persian physician, was the most prominent and famous intellectual of his time. His contributions spanned philosophy, astronomy, mathematics, and medicine. His most renowned work was the book Al-Qanun fi al-Tibb (The Canon of Medicine), which served as the primary textbook of medicine in Europe well into the 18th century. His complete systematic anthology of medicine was founded on previous works by Galen as well as his own clinical observations of physiology, pathology, and anatomy. Avicenna contributed to neurosurgery by providing descriptions of vertebral anatomy and clinical annotations. In one of his annotations he describes making a cranial incision:

When one decides to make an incision or opening one should take into consideration the various small and larger folds of the skin. In the case of the forehead however one would act otherwise, because an incision along the folds there would divide the muscles and cause drooping of the eyelids. Similar care must be taken in the case where the muscular fibers take a different course to the surface folds. The surgeon must therefore know the anatomy of the nerves, the veins, and the arteries, so as not to sever them by mistake.

Because of Avicenna’s understanding and depiction of the relationship between anatomy, function, and clinical relevance, both The Canon of Medicine and Avicenna himself have survived the test of time. Avicenna dedicated numerous chapters of The Canon of Medicine to the depiction of the spinal cord and the vertebrae. His descriptions—detailed, precise and at times poetic—were composed at a time and place in which religion prohibited human dissections. Though Islamic law forbids surgical investigation of cadavers, it does not restrict surgeons from performing operations on patients in need. Although not specifically documented, it is probable that Avicenna made his observations through the many corrective surgeries he performed.

Avicenna described the spine as having four functions: protecting the spinal cord, protecting the organs of the thoracic cavity, providing structural support for the entire skeletal system, and allowing movement. He described the vertebrae of the cervical, thoracic, and lumbar spine as well as the sacrum and coccyx in great detail. He illustrat-
ed the various processes, foramina, facets, and ligaments. In his description of the anterior and posterior longitudinal ligaments, he stated that the former is stronger than the latter because anterior movement is needed more than posterior movement.

After regional analysis of vertebrae and their presumed functions, Avicenna provided treatment options for back complaints. In the first book of The Canon of Medicine, there are many considerations of spinal injuries and their treatment. For example, Avicenna describes different maneuvers to treat thoracolumbar back pain (Fig. 1).

Avicenna’s depth of understanding of spinal anatomy allowed him to be one of the first to provide ways of stabilizing the spine. In The Canon of Medicine, Avicenna provides treatment options for spinal deformities such as kyphosis as well as for dislocations and fractures of the vertebrae. He not only described what he observed, but also tried to provide a rational explanation for the anatomy. He argues that without the spinal cord:

Nerves innervating the hands and feet would travel a longer distance and, thus be more prone to injury...Therefore, God created the spinal cord below the brain. The spinal cord is like a channel coming out of a fountain in the way that nerves emerge from both sides and go down, thus putting the organs closer to the brain.”

Although Avicenna’s greatest contribution to modern neurosurgery was his depiction and explanation of the spine, he also contributed observations on intracranial anatomy and pathology. His assessment of intracranial anatomy divided the brain into the cortex and medulla. He had an in-depth understanding of the brain as described by his predecessors, specifically Galen, who went so far as to attempt to number the cranial nerves. Avicenna described intracranial disease, like meningitis, and conditions such as hydrocephalus. He also performed cranial and intracranial surgeries and interventions such as bur hole trephination (Fig. 2).

The Canon of Medicine by Avicenna chronicles major advancements in the field of neurosurgery, which—along with the contributions of other intellectuals of the time, like Albucasis and Rhazes—distinguishes the medical and surgical enlightenment achieved at this time.

Abul-Qasim Al-Zahrawi (Albucasis)

No discussion of medieval medicine would be complete without mention of the physician and scholar Al-Zahrawi (AD 936–1013). Known in the Western literature as Albucasis, he was born in Al-Zahra, a royal city near Cordoba, Spain. By the beginning of the ninth century Moorish culture was flourishing following the movement of North African armies into southern Spain.

Albucasis was a scholar and compiler who wrote more than 30 volumes on all subjects pertaining to medicine. His final volume, a treatise on surgery, includes several chapters devoted to neurological surgery. He addressed a wide variety of neurosurgical issues including head injuries with skull fractures, spinal injuries, hydrocephalus, and cauterization. He described skull fractures as penetrating or crushing. He accurately described a "ping-pong" type of skull fracture as what one would see when a dent is made in a metal bowl from an object falling on it. Albucasis was a pioneer in developing surgical instruments. He was the first to introduce a nonsinking trephine for skull access, using a circular margin beneath the sharp head in order to avoid plunging into brain tissue with the trephine. Albucasis discussed spinal injuries extensively in his works. He described immobilization and traction for spinal dislocations. He accurately stated that severe dislocations lead to bowel incontinence and limb paralysis, with death ensuing shortly after injury. Albucasis included hydrocephalus and its treatment in his writings. He wrote that fluid may collect between the bone and meninges and that a deep incision below the bone could relieve this pressure. Albucasis was the first physician to explain a surgical treatment option for the temporal headache syndrome now known as temporal arteritis. He explained that relief from headaches could be provided by cauterizing the superficial temporal artery or ligating it with thread. In addition to contributing his extensive discussion of brain and spine anatomy, he also contributed immensely to surgical technique. He advocated the use of cauterization in a wide variety of surgical procedures. He was well aware of the need for aseptic technique and used alcohol from wine during surgical procedures.

Albucasis was ahead of his time in the realm of neurosurgery. His contributions were crucial in bridging the knowledge gap in the world of medicine from the Middle Ages to the more modern period following the 15th century.
Abu Bakr Muhamed Ibn Zakaria Al-Rhazes (Rhazes)

Rhazes (AD 864–930) was born in Rayy, a city that was near modern Tehran. His work included over 200 scientific documents in which he catalogued and elaborated on the works of Hippocrates and Galen. In addition to being a dedicated teacher, Rhazes was a master clinician. Both students and patients sought his help for the most advanced cases that puzzled many others.

After establishing himself as a prominent physician, Rhazes was appointed a court physician in Baghdad in AD 907. Over the course of his life Rhazes wrote many treatises on various medical subjects. The best known of these is *Kitab al-Hawi fi al-Tibb*, also known as *Liber Continens*, a 25-volume encyclopedia that includes translations of the work of Greek, Indian, and Arab physicians as well as anecdotes from Rhazes’ own personal experiences. Rhazes’ contribution to neuroanatomy is well documented in his works in *Kitab al-Hawi fi al-Tibb* and *Kitab al-Mansuri fi al-Tibb*. He described nerves as having both motor and sensory functions and as originating in pairs from the brain and spinal cord with membrane coverings. Rhazes also stated that there were seven cranial and 31 peripheral nerves, assigning them the order initially given by Galen. He divided the peripheral nerves into eight cervical pairs, 12 thoracic pairs, five pairs in the lumbar spine, and three in the sacral spine, and he used this knowledge of segmental nerve innervations to localize lesions in patients. He described a man who became paraplegic as a result of a back injury with sparing of the upper extremities due to sparing of the cervical spine. Rhazes was also the first physician to describe concussion as it is recognized today and distinguished the term from severe brain injury.

Some have argued that Rhazes lacked new ideas, implying that his work mirrored Galen’s. Although Rhazes revered Galen’s work and frequently referenced it in his treatises such as *Kitabal-Mansuri*, he also respectfully criticized some of his theories. For example, contrary to Galen’s belief that the brain, spinal cord, and ventricular system were single structures, Rhazes correctly hypothesized that these were paired structures.

Historically, Rhazes has not received the same recognition as Albucasis or Avicenna as a pioneer in neuroanatomy and neurology. Nevertheless his descriptions and understanding of cranial and spinal anatomy along with their clinical applications will always be remembered in the annals of medicine.

Conclusions

In the beginning of the eighth century, the intellectual center of the world shifted eastward and flourished until the beginning of the 13th century. During this period, the work of Middle Eastern physicians such as Avicenna, Albucasis, and Rhazes was of paramount importance in guarding the knowledge that had been accumulated throughout history, particularly the contributions of Greek and Roman scholars. In addition to preserving this wealth of knowledge, these Middle Eastern scholars made significant contributions of their own to both medicine and neurosurgery.

References


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