The bishop and anatomist Niels Stensen (1638–1686) and his contributions to our early understanding of the brain

R. Shane Tubbs · Martin M. Mortazavi ·
Mohammadali M. Shoja · Marios Loukas ·
Aaron A. Cohen-Gadol

Published online: 11 August 2010
© Springer-Verlag 2010

Abstract Many physicians are familiar with the parotid duct and the Danish physician/anatomist's name associated with it. However, most are unaware of Niels Stensen's life and his significant contributions to the early study of the brain. This physician of the Medici court was clearly ahead of his time and found errors in the publications of such giants as Varolius and Willis. The present review discusses the life of this seventeenth century anatomist, physician, and priest/bishop and highlights his contributions to neuroanatomy.

Keywords Brain anatomy · Neuroanatomy · Stensen

*“Fair is what we see, Fairer what we have perceived,
Fairest what is still in veil.”*

Niels Stensen

Early life

The Dane Niels Stensen (Latin *Nicolaus Stenonis*) was born on January 11, 1638, and died on November 25, 1686, and was a pioneer in both anatomy and geology (Fig. 1). A native of Copenhagen, Denmark, Stensen began his education in the country's most exclusive school, the grammar school Vor Frue (1647–1656). In 1654–1655, when Stensen was 16, over 200 students of his school died of the plague that killed approximately one third of Copenhagen's population [1]. Stensen was born during the 30 Years War, and interestingly, was related to the famed Danish-born anatomist James Benignus Winslow (foramen of Winslow). He was the son of parents of the upper middle class, Sten Pedersen and Anne Nielsdatter, who came from the Danish province of Fyn [2]. His father was a goldsmith who worked regularly for King Christian IV of Denmark and whose family derived from Lutheran ministers in Skåne. In 1644, his father died, after which his mother, interestingly, remarried another goldsmith. Stensen was very astute and considered by some to be a savant, speaking fluent German, Dutch, French, Italian, Latin,

---

R. S. Tubbs · M. M. Mortazavi
Section of Pediatric Neurosurgery, Children's Hospital,
Birmingham, AL, USA

M. M. Shoja · A. A. Cohen-Gadol (✉)
Department of Neurological Surgery, Indiana University,
Clarian Neuroscience, Goodman Campbell Brain and Spine,
1801 North Senate Blvd # 610,
Indianapolis, IN 46202, USA
e-mail: acohenmd@gmail.com

M. Loukas
Department of Anatomical Sciences, St. George's University,
St. George, Grenada

Fig. 1 Stensen (1638–1686) as Bishop

Greek, Hebrew, and Arabic [2]. He eventually attended the university in Copenhagen (Københavns Universitet) (1658–1660) studying medicine, mathematics and philosophy, and in 1660, left Copenhagen to study at the University of Leiden in the Netherlands for 3 years.

After brief visits to Paris and Montpelier, Stensen moved to Florence, Italy in 1665–1666. In Italy, Grand Duke Ferdinand II of the Medici palace appointed Stensen to a hospital post that left him time for research [3]. Later, he was elected to the *Accademia del Cimento* (Experimental Academy), a body of researchers inspired by Galileo's experimental and mathematical approaches to science. Stensen traveled through Europe visiting France, Germany, and the Netherlands. In Leiden, he met renowned individuals such as Jan Swammerdam, Frederik Ruysch, Reinier de Graaf, François de la Boë Sylvius, and the famous Jewish philosopher Baruch Spinoza [2]. In Montpelier, he met Royal Society members Martin Lister and William Croone, who introduced Stensen's work to this group [1]. While in Rome, he met Alexander VII and Marcello Malpighi, the founder of microscopic anatomy [2].

Anatomical contributions

Eventually, fellow Dane and teacher Thomas Bartholin, persuaded Stensen to study in Rostock and Amsterdam where he excelled in anatomy with anatomist Gerard Bläes. In fact, a physician visiting Paris in 1665 stated “he (Stensen) could count the bones of a flea- if fleas have bones” [1]. As an anatomist, he made multiple discoveries

that included determining that the heart was simply a muscle. He also described tongue muscles, the esophagus, and named the levator costae muscles. Stensen's name is also associated with the discovery of the lateral foramina (incisive foramina) of the anterior hard palate that carry branches of the descending palatine vessels (Stensen's foramina) [4] and the vorticose veins of the eye (Stensen's veins). He discovered the tarsal glands of the eyelids and understood that the lacrimal glands and not the brain produced tears [2]. Stensen rediscovered the vitelline duct in 1664 and discovered and named the follicles of the ovary in 1667, although he did not publish this discovery regarding the follicles until 1675, 3 years after his colleague de Graaf. In 1667, he postulated that the ovary in the female was not a female testis but was a distinct organ that corresponded to the egg-producing organs of birds and reptiles. He verified the existence of Peyer's patches in 1673 and demonstrated that a ligature placed around the descending aorta resulted in paralysis of the lower limbs and that removing the ligature restored function (Stensen's experiment). He found that glands produced the cerumen of the ear canal [2]. His best known anatomical works included *Anatomical Observations* and *Elementary Myological Specimens* published in 1662 and 1669, respectively [5, 6]. Serendipitously, Stensen discovered the parotid duct (Stensen's duct) in sheep, dog, and rabbit heads and is most remembered for this observation. In a letter to Thomas Bartholin, he stated,

“having been allowed to dissect on my own, I succeeded in the first sheep's head which I purchased and dissected by myself in the study hall on April 7 in finding a duct which—as far as I know—has not previously been described. It was my intention after removing the ordinary outer parts to do a section of the brain when I happened to decide first to examine the vessels running through the mouth. Examining with that intention the course of the veins and arteries, by inserting a probe I observed that the point is no longer enclosed in the narrow sheath but moves freely in a spacious cavity; and pushing the instrument further forward, I at once heard it clink against the teeth themselves [7].”

Elsewhere in his letter to Bartholin, Stensen referred to his discovery as an *inventiuncula*—a small observation.

Conflict

Although the parotid duct was discovered by Stensen, his teacher, Bläes, laid claim to its discovery in 1661. This dispute with Bläes resulted in Stensen enrolling at the University of Leiden on July 27, 1661. It was here that he

began compiling his *Anatomical Observations*, which he published in 1662 and dedicated to his professors in Copenhagen and Leiden, a group that included the mathematician Jakob Golius (1596–1667) who was a student of Galileo's (as was Ferdinando II, the brother to Stensen's Medici benefactor, and Vincenzo Viviani (1622–1703), a future collaborator) [2]. Two years later, Bläes again attempted to convince others that he had discovered the parotid duct; however, this time Stensen publically dismissed his claim in an official publication in 1663.

Although earlier in his career, Stensen's former professor Thomas Bartholin, had referred to him as the “royal anatomist” and the century's “new Democritus,” Bartholin later became envious of Stensen and tried to block his academic ascent by, for example, hiring his own nephew Mathias Jacobsen instead of Stensen [2]. As anatomist, Stensen became well known across Europe by his public demonstrations of anatomical dissections in the *Theatrum Anatomicum*. In 1664, from the University of Leiden, came the news that due to Stensen's “uncommon learning,” he had been made a doctor of medicine in absentia [8].

Neuroanatomy

While in Paris and lodging in the house of Melchisédech Thévenot (Louis XIV's chamberlain, librarian, and former French ambassador to the republic of Genoa) [2], Stensen attended academic sessions that later led to the establishment of the Académie royale des Sciences in 1666 [2]. It was in 1665 and to this precursor of the Académie royale des Sciences that Stensen presented, in perfect French, his renowned lecture on the anatomy of the brain (Fig. 2) [7]. He began by saying how ignorant he was of the brain, this “the most beautiful masterpiece of nature,” that is the principal organ of our mind. “Our mind thinks that nothing can set a limit to its knowledge, but when it withdraws to its own habitation it is unable to give a description of it, and no longer knows itself.” With good reason, he criticized earlier theories that the brain was connected with the mind through an egg-shaped gland. That sort of thing was no more than “ingenious speculation,” Stensen declared. He compared the brain with a machine that one could understand only by taking it to pieces down to its smallest parts. He opposed Descartes, arguing that it was erroneous to speculate about cerebral function when so little was known about the anatomy of the brain. In his dissertation on the brain, Stensen stated

“It would be a great blessing to mankind if this most delicate part, and which is liable to so many dangerous diseases, were as well understood as the generality of anatomists and philosophers imagining it

to be...as if they had been present at the formation of this surprising machine, and had been let into all the designs of the Great Architect. We need only view a dissection of the large mass, the brain, to have ground to bewail our ignorance. Let us without flattering ourselves any longer, freely acknowledge our ignorance, that we may not first deceive ourselves and others afterwards, by promising to show them the true structure of this organ” [7].

Ventricles

“The ancients were so far prepossessed about the ventricles as to take the anterior for the seat of common sense, the posterior for the seat of memory, that the judgment which they said was lodged in the middle, might more easily reflect on the ideas which came from either ventricle. Why should we believe them? Willis lodges common sense in the corpora striata, the imagination in the corpus callosum, and the memory in the cortical substance. How can he then be sure that these three

DISCOVERS DE MONSIEVR STENON, SVR L'ANATOMIE DV CERVEAV.

A
MESSIEVRS DE
*l'Assemblée, qui se fait chez
Monsieur Thevenot.*

A PARIS;
Chez ROBERT DE NINVILLE, au bout du Pont
S. Michel, au coin de la ruë de la Huchette,
à l'Eſcu de France & de Nauarre.

M DC. LXIX.
AVEC PRIVILEGE DV ROT.

Fig. 2 Title page of Stensen's work on the brain, *Discours sur l'anatomie du*, 1669

operations are performed in the three bodies which he pitches upon? Who is able to tell us whether the nervous fibers begin in the corpora striata, or if they pass through the corpus callosum all the way to the cortical substance? We know so little of the true structure of the corpus callosum that a man of tolerable genius may say about it, whatever he pleases (Fig. 3)” [7].

Pineal gland

Stensen rejected Descartes' idea that the pineal gland was the link between the body and soul stating

“The supposed connection of this gland (pineal) with the brain by means of arteries is likewise groundless: for the whole basis of the gland adheres to the brain, or rather the substance of the gland is continuous with that of the brain, though the contrary be affirmed by Descartes (Fig. 3). (Moreover), it is not known whether the pituitary gland acts in any respect on the pituita (mucous)” [7].

Brain in general

“The best figures of the brain are those of Willis; but even these contain a great number of important mistakes, and they want many things to perfect them. I have seen but three figures of Varolius, which express in a wretched manner, the best observations that have ever been published on the brain. The principal reason why a great many anatomists have

remained in their mistakes, and why they have gone no greater a length than the ancients in dissection, is because they believe that everything has been already taken notice of, and that there is nothing left for the moderns to do (Fig. 4)” [7].

Geologic contributions

In addition to his significant contributions to the field of anatomy, Stensen is also regarded as the Father of Geology, and interestingly, the root of his surname means “rock” [2]. Stensen's work on shark teeth led him to question how one solid could come to reside within another solid. While examining these specimens, Stensen was struck by their resemblance to *glossopetrae* or “tongue stones” [7]. Ancient authorities, such as the Roman author Pliny the Elder, had suggested that these stones fell from the sky or from the moon and some believed that these structures were serpent tongues turned to stone by St. Paul. Stensen argued that *glossopetrae* were simply fossilized shark teeth. With such discoveries, Stensen is credited with developing the principles that led to the science of stratigraphy and for establishing the foundation on which Darwin's theory of natural selection would be based [8]. Stensen's writings in this field continue to be used by geologists and paleontologists today.

Religious convictions

While in Florence, Stensen began to question his Lutheran upbringing. After intense comparative study, he decided that Catholicism, rather than Lutheranism, was more

Fig. 3 Drawing made of a sagittal section of the brain from Stensen's *Discours sur l'anatomie du cerveau* noting his appreciation for anatomical relationships

Fig. 4 Drawing of a parasagittal section of the brain from Stensen's *Discours sur l'anatomie du cerveau*

Fig. 5 Tomb of Stensen from San Lorenzo, Florence. Courtesy of Luca Borghi, Himetop—The history of medicine topographical database

consistent with his religious views and, therefore, converted to Catholicism on All Souls' Day November 4, 1667 to become one of the leading figures in the Counter-Reformation [3]. Not long after his epiphany, Stensen returned to Florence and was ordained a priest in Florence's Cathedral on Easter Eve 1675 [2]. Despite his accomplishments, Stensen's fellow Dutchman refrained from promoting him to the level of professor at the University of Copenhagen. This resulted in Stensen moving to Florence, where he was cordially received by the Medici and appointed as anatomist at the Santa Maria Nuova hospital [7]. Shortly after Stensen's conversion to Catholicism, a royal letter from the Danish king Frederick III arrived announcing his appointment at Copenhagen University, but while Stensen awaited free religious worship status, the king died [1]. It was, therefore, not until 1672 that Stensen was able to return to Copenhagen. In Denmark he was appointed *anatomicus regius* since a Catholic could not hold the position of professor [1]. Stensen wrote: "This is the true purpose of anatomy: To lead the audience by the wonderful artwork of the human body to the dignity of the soul and by the admirable structure of both to the knowledge and love of God" [2].

Stensen went to Rome where he was appointed apostolic vicar of northern missions by Pope Innocent XI on August 21, 1677 and was consecrated titular bishop of Titiopolis in Asia Minor (present day Turkey) on September 19 [2, 3]. Later the same year after being appointed Apostolic Legate for Northern Germany and Scandinavia, he left Rome to minister to the minority Roman Catholic populations in northern Germany, Denmark, and Norway [2]. Stensen worked in Hannover until 1680 when he accepted a position in Münster. As an example of his devotion to his religion, Stensen sold his bishop's ring and cross to help the needy and is said to have dressed like a beggar and ate little, becoming so malnourished that one friend described him as a "living corpse" [1].

In 1684, Stensen moved to Hamburg and again studied the brain and the nervous system with his friend, the famous Dutch anatomist Theodor Kerckring. Stensen was invited to Schwerin and spent some of the last years of his life ministering to the Catholics who had survived the protracted 30 Years War [1]. He had wished to return to Italy but became seriously ill and died in Germany at the age of 48 [7]. At the request of Grand Duke Cosimo of Tuscany, his body was taken by his friend Kerckring to Florence and buried in the Medici tombs in the Basilica of San Lorenzo (Figs. 5, 6) [7].

Fig. 6 Stained-glass depiction of Stensen from San Lorenzo, Florence. Courtesy of Luca Borghi, Himetop—The history of medicine topographical database. (This figure is used as cover picture)

Stensen's piety and virtue have been evaluated with the goal of eventual canonization, and centuries after his death, Danish pilgrims appealed to Pope Pius XI to make Stensen a saint [8]. In 1953, as part of this process his corpse was exhumed and reburied in the Capella Stenoniana, a chapel within San Lorenzo. On October 23, 1988, Stensen was beatified (the first step to becoming a saint) by Pope John Paul II and attained the status and title of Blessed (Blessed Nicolas Steno). His day of celebration in the Catholic Church is November 25 [3]. Stensen's name is remembered by the Steno Museum in Århus, Denmark, craters on Mars and the Moon, the Steno Diabetes Center, a research and teaching hospital in Gentofte, Denmark, and the Istituto Niels Stensen, which was founded in 1964 in Florence, Italy and administered by the Jesuit Order.

Stensen's life was short-lived but full of discovery both academically and spiritually. Although he lives on primarily as the eponym “Stensen's duct,” it is his contributions to neuroanatomy that should perhaps be most remembered. It is on the shoulders of giants such as Niels

Stensen that we base our current understanding of the nervous system.

References

1. Cutler A (2003) *The seashell on the mountaintop: a story of science, sainthood, and the humble genius who discovered a new history of the earth*. Dutton, New York
2. Kermit H (2003) Niels Stensen, 1638–1686: the scientist who was beatified. *Gracewing*, Leominster
3. Sobiech F (2005) Blessed Nicholas Steno (1638–1686) *Natural-History research and science of the cross*. *Austral E J Theol* (5):1448–1632
4. Thane G (1890) *Osteology*. In: Schafer E, Thane G (eds) *Quain's anatomy*, vol II, Part I. Green and Co, London, pp 1–146
5. Stensen N (1664) *De musculis et glandulis observationem specimen*. M. Godicchenii, Hafnia
6. Stensen N (1667) *Elementorum myologicae specimen*. Stellae, Florentiae
7. Stensen N (1950) *A dissertation on the anatomy of the brain with a preface and notes by Edv Gotfredsen*. Nyt Nordisk Forlag Arnold Busch, Copenhagen
8. Cioni R (1662) *Niels Stensen: scientist-bishop*. PJ Kenedy & Sons, New York