Bengt Lilliequist: life and accomplishments of a true renaissance man

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In the 1970s, the membrane of Lilliequist became the accepted name for a small band of arachnoid membrane separating the interpeduncular and chiasmatic cisterns, making it one of the most recent of the universally accepted medical eponyms. The story of its discovery, however, cannot be told without a thorough understanding of the man responsible and his contribution to the growth of a specialty. Bengt Lilliequist lived during what many would consider the Golden Age of neuroradiology. With his colleagues at the Serafimer Hospital in Stockholm, he helped set the standard for appropriate imaging of the CNS and contributed to more accurate localization of intracerebral as well as spinal lesions. The pneumoencephalographic discovery of the membrane that was to bear his name serves merely as a starting point for a career that spanned five decades and included the defense of two separate doctoral theses, the last of which occurred after his 80th birthday. Although the recognition of neuroradiology as a subspecialty did not occur in his home country of Sweden until after his retirement, and technological progress saw the obsolescence of the procedure that he had mastered, Dr. Lilliequist's accomplishments and his contributions to the current understanding of neuroanatomy merit our continued praise.

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THE study of human anatomy is replete with structures bearing the names of the people responsible for their discovery or initial description. In many cases, individual structures may be known by more than one eponymous moniker depending on the source queried or the geographic location of its usage. Beginning in the late 19th century and continuing until the present day, one of the central goals of several international federations of anatomists has been to remove these terms from the current lexicon.^{8,16,33} While the usage of eponyms has slowly and systematically faded from the academic anatomical parlance, selected terms have continued and will continue in the clinical usage for their purely historical significance.

While names like Fallopian and Eustachian have been a part of descriptive anatomy for centuries, most neurosurgeons would be surprised to learn that the eponymous name given to the arachnoidal membrane separating the interpeduncular from the chiasmatic cistern derives from a man who was still practicing medicine in the late 20th century. In fact, Bengt Lilliequist, prior to his death in 2008, may have been the last man alive to have a human anatomical structure named for him.⁷ His history and the

history of the membrane he described is a story that has yet to be told in any great detail.

Birth and Family Life

Bengt Eric Lilliequist was born on February 11, 1923, in Norrköping, in the province of Östergötland in eastern Sweden.²² His father, Knut Eric Lilliequist, having received his juris kandidat (Master of Laws) in Stockholm in January of 1921, proposed and was married to Astrid Sofia Amalia Stagh on April 17, 1922. Knut served as an assessor, notary, and acting magistrate in several counties, before settling in Jönköping County, where he ultimately became the first County Clerk. Astrid worked for the Swedish telephone company, Televerket.

Bengt's parents were married for 10 months before they celebrated his birth. Knut and Astrid proceeded to have 3 additional children within the next 10 years. Bengt's oldest brother, Axel Gunnar Birger Lilliequist, graduated from the military academy and worked in the insurance industry, ultimately moving to Thailand. His only sister, Astrid Märta Elizabeth Lilliequist, married a local boy from

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Jönköping and worked as a preschool teacher. Axis Bertil Liliequist, Bengt's youngest brother, was born in 1933, and like his older brother Axel worked in the insurance business, for Skandia.

In 1948, Bengt married Lizzie Thörnblad, the daughter of Erik and Karin Carlsson Thörnblad, at Solna Church in Stockholm. Three years later, they started their family with the birth of their first son, Jonas. He, like his father, was committed to academics and subsequently became an associate professor and historical researcher at Umeå University. The Liliequists' second son, Lars, was born in 1954 and grew up to become an art teacher in Stockholm.

In 1952, when he was 29 years old, Bengt lost his mother to a premature death at the age of 57. The Liliequist children (and grandchildren) had the joy of their "farfar," Knut, for many years to follow, until his death at 78 years of age in 1972.

Education

Bengt received his Baccalaureate in Jönköping in 1942 and his Bachelor's degree from Uppsala University in 1945. He completed his medical degree at Uppsala in 1950 and served as underläkare (junior doctor) in diagnostic radiology at Falun Central Hospital in south-central Sweden from 1950 to 1953. He continued his internship training at Södersjukhuset and Sabbatsberg hospitals in Stockholm in 1953, prior to his promotion to first underläkare (first junior doctor) at Serafimer Hospital (Serafimerlasarettet) in Stockholm, where he served from 1953 to 1959. It was here, at the "Mecca of neuroradiology,"¹³ that Liliequist first received training in the methods of pneumoencephalography and cerebral angiography with his colleague Torgny Greitz. In the early 20th century, Serafimer developed an international reputation under Erik Lysholm and Erik Lindgren for simultaneously establishing the rigorous diagnostic guidelines of the developing field of neuroradiology, while also training the future leaders in the field.¹³

Description of a Fold in the Arachnoid Membrane

Following the discovery of the arachnoid membrane in the 17th century by Blasius, Ruysch, and Vieussens, it had been described as anything from a single continuous sac enveloping the brain⁵ to a potential space with occasional small islands of fluid without communication.^{2,24,26,27,29,31} Bichat, in his 1800 monograph "A Treatise on the Membranes," was the first to describe the complex interconnections of the arachnoid membrane at the cranial base, although he still considered it a closed serous sac, similar to the pleura.^{3,24,27} In 1842, Magendie was the first to demonstrate free communication of fluid between the ventricles and the subarachnoid space.³² In addition to discovering and naming the aperture in the fourth ventricle that bears his name, Magendie also described 5 interconnected "confluents" in the arachnoid.³⁰

In 1869, two Swedish anatomists at the Institute for Pathological Anatomy of the Karolinska Institute named Axel Key and Gustaf Retzius began an elegant set of experiments involving ventricular dye injection. Their re-

sults were compiled into a beautifully illustrated manuscript titled *Studien in der Anatomie des Nervensystems und des Bindegewebes* in 1875 (Fig. 1).¹⁷ Here, in addition to confirming the work of Magendie and Luschka, Key and Retzius were the first to definitively demonstrate free communication of CSF through fenestrations in the arachnoid.^{14,15} They are credited with naming each of the basal cisterns, as well as identifying the "membrane dividing the interpeduncular cistern into deep and superficial portions."^{6,17,21}

In the 1950s at Serafimer, Sweden's next generation of neuroradiologists were beginning to notice inconsistencies between their imaging of the brain and spinal cord and the neuroanatomy presented in the textbooks of the day.¹³ Liliequist had the good fortune of completing his medical training at this facility while it was in the midst of its Golden Age. While colleagues like Torgny Greitz were utilizing Moniz's angiographic techniques (or "färgskalle") to more accurately describe the intracranial vasculature, Bengt was perfecting Dandy's pneumoencephalography to build upon the work of Key and Retzius. During these studies, he noticed that air rising from the

FIG. 1. Illustration from *Studien in der Anatomie des Nervensystems und des Bindegewebes* by Key and Retzius,¹⁷ demonstrating the appearance of human cadaver heads following the injection of colored dye. The blue dye indicates free communication of spinal fluid through fenestrations in the arachnoid. This figure is in the public domain. Figure is available in color online only.

lumbar cistern would gather at the interpeduncular cistern and pause prior to slowly passing to the chiasmatic cistern. This curious finding led him to perform a cadaveric study to further elucidate the anatomical positions of the subarachnoid cisterns, the findings of which he compiled into Part II of his doctoral thesis *The subarachnoid cisterns. An anatomical and roentgenologic study*. Here, he calls into question the findings of some of his contemporaries, specifically Davidoff and Dyke, who referred to the interpeduncular cistern as a continuous space extending “as far anteriorly as the caudal margin of the optic chiasm and the internal carotid arteries.”¹⁸ Liliequist responded that, “There is however, a thin arachnoidal membrane in this subarachnoid space. This membrane is often seen in the encephalogram as a fine line with a convexity forwards, extending from the tip of the dorsum of the sella to anterior edge of the mammillary bodies.”

An excerpt of Liliequist’s manuscript was published in 1956 in *Acta Radiologica*,¹⁸ with the complete thesis included as successive supplements in 1959^{20,21} as was the tradition for graduating theses from Serafimer (Dr. Liliequist defended a 2-part thesis including Part I: *Pontine angle tumor. Encephalographic appearances* [96 pages], and Part II: *The subarachnoid cisterns. An anatomical and roentgenologic study* [108 pages]. Original manuscripts are part of Peter Liliequist’s personal collection²²). The acceptance of the eponym “membrane of Liliequist” was by no means immediate, as Bernard Epstein continues to refer to a “transverse arachnoidal membrane” in his myelographic study of 1965, although he does credit its description to Liliequist.⁶ The eponym first appeared in print in 1976, in Dr. Yaşargil’s landmark description of the cisterns, effectively cementing its place in neurosurgical and anatomical parlance³⁴ (Fig. 2).

Interest in what came to be known as Liliequist’s membrane has been revitalized in recent years with continued improvement in MRI technology and the widespread usage of the endoscope in neurosurgical procedures. The 25% rate of failure following endoscopic third ventriculostomy has led many contemporary investigators to more closely evaluate the precise anatomical relationships of this fold in the arachnoid.^{4,10,11,30} Although modern investigators have identified additional leaflets in his membrane and more precisely clarified their attachments to vital structures, Liliequist’s original descriptions have been repeatedly confirmed.^{4,12,14,23,25,30,35}

Professional Life

Dr. Liliequist sat for his medical board examination, defended his thesis, and was promoted to physician in 1959 at the Karolinska Institute, the same year his friend, Torgny Greitz, became head of the Department of Radiology at a newly opened university in Umeå.¹³ In 1960, Bengt moved his family the 500 km to Umeå in Northern Sweden, where he was subsequently installed as Senior Registrar in diagnostic radiology. Three years later, when Greitz was chosen as the first Professor of Neuroradiology at the Karolinska Institute in Stockholm, Liliequist assumed the department at Umeå, including responsibility for neurologic and pediatric radiology.¹³ Over the next 2 decades, the exact-

FIG. 2. Illustration from Yaşargil’s 1976 treatise, “Anatomical observations of the subarachnoid cisterns of the brain during surgery,” detailing the orientation of the major subarachnoid cisterns as viewed from a left pterional approach. The membrane of Liliequist is depicted as a thickened layer separating the chiasmatic (6) and interpeduncular (7) cisterns. 1 = medial basal part of Sylvian cistern; 2 = olfactory cistern; 3 = carotid cistern; 4 = lateral upper part of the interpeduncular cistern; 5 = crural cistern; 8 = callosal cistern. Reprinted with permission from Yaşargil et al: *J Neurosurg* 44:298–302, 1976.

ing standards and commitment to academic advancement gained at Serafimer would help him build a world-class department and contribute to the burgeoning field of neuroradiology, not just in Sweden, but worldwide.

In 1973, Liliequist was one of the first radiologists in Sweden, and thereby the entire continent, to experiment with CT for imaging the brain. Not surprisingly, when the funding was secured for purchase of the first scanner, it was placed in Greitz’s department at the Karolinska.¹³ Only 2 years later, Umeå University and Liliequist’s department received the second unit in Sweden.¹³

Liliequist also played a prominent role in the growth of the specialty of neuroradiology outside of Umeå. In 1969, he served as one of the 10 founding members of the European Society of Neuroradiology. Two years later, at the March meeting of the Swedish Society of Radiology, then chairman George Fredrik Saltzman appointed Liliequist as secretary of the interim board tasked with creating a Swedish Society.²⁸ On November 26 of that year, the Swedish Society of Neuroradiology was founded with Erik Lindgren as president, Torgny Greitz as vice president, and Bengt Liliequist as secretary.²⁸ The first scientific meeting was held in Stockholm on May 25, 1972, with membership set at 10 kronor, or about \$1.50 US. Both societies worked continually for the recognition of neuroradiology as a separate specialty, a goal not realized in Sweden until 1991.

Liliequist was promoted to senior consultant in 1965, and in 1981 achieved the rank of professor, a title he maintained until his retirement in 1987.⁷ At his retirement, Liliequist was credited with authoring or contributing to 75 peer-reviewed publications.

Retirement and a New Life in Academics

As with all high achievers, Dr. Liliequist was not satisfied to quietly wile away his final years in peaceful isolation. He used his newfound free time to catch up on his reading and to reflect upon the role the scientific method had played in his career and the development of the science of medicine. One of the first works he read was that of Ludwik Fleck, a turn of the century Polish bacteriologist and philosopher, titled *The Genesis and Development of a Scientific Fact: An Introduction to the Theory of Thought Style and Thought Collective* (Translation of original German title: Entstehung und Entwicklung einer wissenschaftlichen Tatsache: Einführung in die Lehre vom Denkstil und Denkkollektiv). Dr. Liliequist stated that he was drawn to the philosopher as he related to him on many levels.⁷ Like himself, Fleck was a physician-scientist who based his theories on cognition upon examples in medicine, as opposed to his closest contemporary, Thomas Kuhn, who relied upon his background in physics. Liliequist believed part of the reason that Fleck's work did not have a wider audience was due to its exclusive publication in German, although he himself had little difficulty, having been forced to learn German in medical school to read his textbooks and publish his first papers. Liliequist subsequently published a complete translation of *The Genesis and Development of a Scientific Fact: An Introduction to the Theory of Thought Style and Thought Collective* from original German into Swedish in 1997.⁹

Liliequist's commitment to the study of Fleck culminated in the defense of his second doctoral thesis, *Ludwik Flecks jämförande kunskapsteori* (Ludwik Fleck's Comparative Theory of Cognition).¹⁹ He showed that Fleck argued that all knowledge is relative, in direct opposition to the logical positivism of his day. In medical terms, he believed that human disease does not exist in and of itself, but represents the medical community's currently accepted combination of symptoms and signs. Fleck argued that a gradual reevaluation of the facts leads to slow progress in understanding, in direct opposition to the periods of "normal science" and abrupt "paradigm shifts" or "changes" proposed in Kuhn's *The Structure of Scientific Revolutions*.

In May of 2003, at the age of 80, Dr. Liliequist was awarded his PhD in philosophy and joined the Department of Philosophy and Linguistics.⁷ On November 26, 2006, he was added to the rolls as Emeritus Professor, a title he was able to maintain for only 2 years.¹ On August 19, 2008, Umeå University mourned the death of its first double doctorate.

Conclusions

The life and accomplishments of Bengt Liliequist far exceed the description of the folded arachnoid membrane for which he will be remembered. His commitment to life-long learning and contributions to the development of a new field are inspiring and bear continued repeating.

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Conception and design: both authors. Reviewed submitted version of manuscript: both authors.

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