

Gabriele Fallopio (1523–1562) and his contributions to the development of medicine and anatomy

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Published online: 11 September 2012
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Abstract

Introduction Gabriele Fallopio was one of the greatest anatomists of the sixteenth century. He discovered and named numerous parts of the human body. His name survives to this day as it is associated with several anatomical structures including the Fallopian canal, Fallopian hiatus, Fallopian valve, Fallopian muscle, and the Fallopian tube.

Conclusions Our current knowledge of human anatomy is based on giants such as Fallopio. His contributions to neuroanatomy laid the foundations for the development of this discipline.

Keywords History · Italy · Anatomy · Medicine

Introduction

Early life

Fallopio (Fig. 1) was born around 1523 in Modena, a small town in Southern Italy to Geronimo and Caterina Fallopio. His father belonged to a noble family. He initially worked as a goldsmith but went on to become a soldier. Later on, Geronimo contracted syphilis and died when Fallopio was only

10 years old. After his father's death, the family faced financial difficulties, which in 1542 forced Fallopio to leave his education and become a priest at a young age in the Episcopal Church in his hometown, inheriting his uncle's canonry. Although Fallopio did not practice his priesthood, with the help of his uncle, he received an ecclesiastical benefice for years, until he officially renounced his state as a priest [1–3].

A gifted student

After financial improvements, Fallopio turned to study medicine in his hometown under Niccolo Machella, who allowed him to dissect his first corpse of a hanged 21-year-old female criminal. In order to earn more money, Fallopio also practiced surgery, to which he did not have much interest initially. However, due to fatal outcomes, he soon abandoned this and decided to study medicine before pursuing surgery any further [2, 4]. However, history is quiet regarding the time from when he left his initial surgical practice until he returned to practicing surgery until he was appointed the Chair of Anatomy and Surgery in Padua. During the 1540s, Fallopio moved to Ferrara, one of the best medical schools in Europe at that time, and studied under Antonio Musa Brasavola and Giambattista Canano. Later, he left Ferrara to continue his education in the University of Pisa, where he became a lecturer and, later, professor of anatomy. He also spent some times in Padua under the supervision of Giambattista da Monte and Matteo Realdo Colombo [2, 5, 6]. Whether or not Fallopio was a student of Vesalius or not is controversial, and his own statement that he was a pupil of Vesalius does not mean it was in Vesalius's presence [5].

Rising career

As student of legendary teachers, Fallopio's skills developed quickly, and his progress became more refined under this

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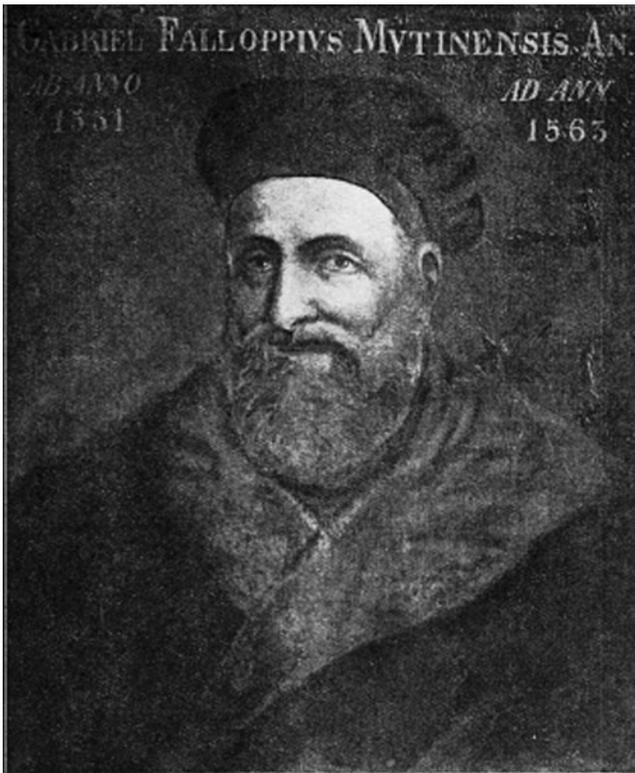


Fig. 1 Gabriele Fallopio (1523–1562)

guidance as he began to make a name for himself. His skills did not go unnoticed as he was appointed as the Chair of Pharmacy in Ferrara from 1548 to 1549. In 1549, the Duke of Florence, Cosimo de Medici, appointed Fallopio as Instructor of Anatomy at the University of Pisa at the age of 25, a position he held until 1551 [2, 7]. During this period, Fallopio also dissected the bodies of lions in the Medici zoo in Florence, and subsequently opposed Aristotle's theory that a lion's bones have no bone marrow. He was also accused of practicing human vivisection. Despite these charges, his star would rise further as the Venetian Senate, 3 years later in 1551, honored him by appointing him to hold the prestigious position of Professor of Anatomy, Surgery, and Botany at the University of Padua, succeeding Colombo. He held this position for the rest of his life and used it to change the course of medicine [1, 2]. In 1556, he became a member of the Medical College of Venice. Fallopio was unhappy in Padua and in 1561, he negotiated with the University of Bologna to move there, with a salary of 400 scudi, twice the one he had in Padua. This, however, never happened due to his death [3].

A distinguished anatomist, physician, and teacher

Fallopio's prodigious skills as an anatomist were based on his ability to scrutinize cadavers and effectively describe the details he observed. He would meticulously dissect the body

and study it. His name was well known across Italy, as in 1552, he went to Rome to treat Baldovino del Monte, the Pope's brother. He was also the family physician to the Este of Ferrara, and medical consultant to the Gonzaga in Mantua [3]. In Venice, in 1561, he would publish all of his findings in *Observation Anatomicae*. This seminal work contained innumerable novel anatomical discoveries and improvements on the work of his contemporaries. He dedicated his book to Petrus Manna in Cremona, the physician of Francesco Sforza II, Duke of Milan [5]. Fallopio is also remembered for being an enthusiastic teacher and a superb lecturer. As an instructor, he would perform the dissections himself and teach refined surgical techniques. His dissections included adults, fetuses, newborns, infants, and children. His enthusiasm inspired many of his students to do research in various branches of medicine. He was a master at intricate operations and his methods were a dramatic improvement from his predecessors. For example, he taught his students how to use the trocar for ascites puncture. He also found a better site for incision than was currently practiced. As a consequence of his fame, he attracted many Italian and foreign doctors to the University of Padua. His ability to accurately describe the body is noteworthy. Fallopio was able to substantially improve on the knowledge of the auditory apparatus and made many discoveries in the area. Fallopio could easily be considered the greatest physician of his time on merit alone [2, 4]. During this historical period, Galen was considered the sole authority in medicine.

Challenging establishment

According to some authors, his book, *Observation Anatomicae* represents a series of observations in an unillustrated commentary on *De humani corporis fabrica* of Vesalius, where he tries to correct errors based on his own observations. This fact affected the popularity of his book, which was considered as a non-inclusive anatomy book [2]. Vesalius wrote a letter attempting to disparage him and his findings but was unsuccessful. Also, in 1564, and in response to one of Fallopio's corrections, Vesalius claimed that he was aware of the existence of the ductus venosus and ductus arteriosus, but he did not mention them in his *Fabrica* [8].

At a time when contradicting Galen was tantamount to heresy, Fallopio would not hesitate to describe unpopular truths and corrected Galen's mistakes, who based most of his observations on animal dissections. For instance, Galen incorrectly wrote that the mandible consists of two bones, the sternum consists of seven segments, and the humerus is the largest bone in the body after the femur. All of these claims, beside many others, were corrected by Fallopio [9]. Also, Galen believed that the male and female sexual organs were analogous. Fallopio was able to prove that the Fallopian tube is a unique organ that connects the uterine cornu to

the ovary [7]. Despite these facts, Fallopio incorrectly contradicted some of the old anatomical beliefs, including his denial of the presence of the venous valves, described earlier by Vesalius [2].

Medical discoveries and inventions

Aside from his very academic approach to medicine and surgery, Fallopio was also an equally distinguished clinician, most significantly contributing to the research of syphilis, which was a virulent disease at the time. Fallopio also described the difference between the luetic (syphilitic condyloma lata) and non-luetic condylomata (condyloma accuminata). He accepted mercury as a therapy, but mentioned the risks of using it, and also used the guaiac plant as a treatment [6, 10].

Although the term condom is attributed to the Earl of Condom who by the order of King Charles II, created an oiled sheath of intestine to protect the king from syphilis, the first known use of the condom can be traced back to Fallopio, whose main effort was to prevent the spread of syphilis. He used a small linen cap drenched in a solution of salt and herbs, and sometimes milk, to cover the glans and under the foreskin and held by a pink ribbon. According to Fallopio, he experimented his invention on 1,100 men, and none of them became infected [10, 11].

Another important contribution was in his methods of treating the nasal polyps. His contributions to the study of anatomy were immense and not limited to any one part of the body. One of his interests was definitely the human sensory systems. In his contribution to the muscles, he wrote about the scalp, face, and many eye muscles and their function including the levator palpebrae muscle and the oblique muscles. He also investigated the extrinsic muscles of the ear, the muscles of the head and neck, and muscles of mastication. He also had lesser contribution in describing the muscles of the trunk and extremities. Also, he was an accomplished dentist. He described the tooth bud and the process of replacement of the primary tooth by the secondary tooth. This has also led to the finding of the connection between the surface mucous membrane and the dental lamina [2, 7]. He also described primary and secondary ossification; mainly in the skull, sternum, and innominate bone [2]. Finally, he left some of his greatest work for the ear. He was the first to clearly describe the round and oval windows, the semicircular canals, the cochlea, and the scala vestibuli. At this time, two of the ossicles had been discovered and he found the third, the stapes [4]. However, some authors mention that it was described before him [2]. Fallopio also named the tympanic cavity “cavum tympani.”

He also delved into other vital components of human physiology: reproductive, vascular, digestive, nervous,

urinary, and developmental systems. He discovered the entire anatomy of the female reproductive system. The uterine or Fallopian tubes are named after him. He found it analogous to the male spermatic ducts and described it as a slender tube of firm consistency and light color. Its resemblance to a trumpet led him to name them “tuba uteri” [12]. He also described the ovaries, vagina, round ligament, the hymen, and similarities between the clitoris and the penis. Muscle fiber and the fact that muscle consists of connective tissue is known thanks to him. He also described the ileocecal (Fallopian) valve. He found the valvulae conniventes and villi of the small intestine. This discovery represented a major advancement for his time. Finally, he also studied fetal development and bone structure. He contributed to the anatomy of the kidney, ureters, and bladder and was the first to observe the straight tubules, the multiple calyces, and the three-layered muscular coat of the bladder. He added many words to the medical lexicon: *placenta*, *vagina*, *cricoid*, and *tympanum* to name a few.

Fallopio’s contributions to neuroanatomy, however, are still of interest today due to attempts to better understand the structures he first found. Aside from the abovementioned discoveries of the sensory systems in the face, he centered his work on understanding the path of the nerves of the face and structures that lie in their tracks. Here, he left his name to two parts of the human face, only emphasizing his enormous influence on the study of the head. The facial canal was first described by Fallopio, who studied its path, structure, and contents. He also described the Fallopian hiatus, an opening in the anterosuperior part of the petrosal bone, which opens into a groove that conducts the greater petrosal nerve and the petrosal branch of the middle meningeal artery. He was the first person to write about the sphenoid and ethmoid bones. This led to the discovery of the sphenoid sinus. He also described in details the chorda tympani, the lacrimal bone, and the lacrimal duct. Consistent with his interest in the function of the ear and mouth, he identified the auditory (CN VIII) and glossopharyngeal (CN IX) nerves. The latter he showed to be separated from the accessory nerve (CN XI). Next, he described the oculomotor (CN III), the trigeminal (CN V), and the hypoglossal (CN XII) nerves. He also traced the trochlear (CN IV) nerve to its origin at the brainstem. He also contributed to the description of the carotid arteries and vertebral artery circulation. In addition to nerves and bones, he was the first to describe the muscles of the soft and hard palates, the pharyngeal muscle, and the pyramidalis (Fallopian) muscle [2, 5, 7].

The official cause of his death remains uncertain but the leading theory is tuberculosis [12]. His date of death was October 9, 1562 [10]. In only 39 years, his life was extraordinarily productive, and he would forever mark his name in the annals of anatomical history.

Hieronymus Fabricius

Fallopio was blessed by a gifted pupil, Geronimo Fabrizio, or Girolamo Fabrici, also known by his Latinized name; Hieronymus Fabricius ab Acquapendente [13–15], who is known as the father of embryology. Fabricius was born in Acquapendente, a small town in the Appennines. The year of his birth is controversial, as some authors reported 1533 [16, 17], others reported 1537 [14, 15]. Around 1550, he was sent to the University of Padua, where, under the patronage of a powerful patrician Venetian family named Lippomano or Lipamano, he studied Greek and Latin, then logic and philosophy. A few years later, Fabricius turned to study medicine in Padua [15–17]. It was during this time when Fabricius met and had the opportunity to work with Fallopio, who was only 14 years older than him. There, Fabricius became his favored pupil and best friend [15, 16]. When he received his medical degree, around 1559, he often substituted for Fallopio as lecturer while the latter visited patients at a distance [15]. However, this friendship ended as fast as it started. In 1562, Fallopio passed away at the age of 39 [15]. Three years later, in 1565, and at the age of 28, Fabricius was honored by the chair of anatomy and surgery at the University of Padua, succeeding his teacher [15, 16]. Fabricius was a brilliant and endowed professor, who gave most of his time to research and dissection, and did not lecture for about 9 years. Some authors explained this by his repeated illness and his difficult personality. However, his works and achievements are still well recognized as leading in many fields of anatomy, embryology, and surgery. Unfortunately, however, some of his works were either lost or unprinted. After serving almost 50 years of teaching in the University of Padua, Fabricius retired in 1613 and died in 1619 [15–17]. One of the most important discoveries by Fabricius is that of the valves of the veins, which were either falsely described or even denied by preceding anatomists [18].

Fallopio will be remembered for many things and for his legacy through his students. He furthered our knowledge of

medicine and anatomy. His contributions to neuroanatomy laid the foundations for the development of this discipline.

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