

# *Antonio Maria Valsalva - Biographical Profile of a Pioneer on Otology*

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## **SUMMARY**

### **Introduction:**

The authors present a biographical profile of Antonio Maria Valsalva and his main achievements, emphasizing his contribution to Otorhinolaryngology and, in particular, to Otology.

### **Review/Discussion:**

Valsalva was born in 1666, in Imola, Italy. He devoted all his life to the study of anatomy, pathology and surgery. His contribution was valuable to the study of pathological anatomy, leaving numerous specimens dissected in autopsies of many different diseases. He proposed innovations as nephrectomy in dogs for tumor resection, as well as new conceptions in the pathophysiology of brain stroke, in ophthalmology, in tumors' surgery and psychiatry. He identified anatomic structures such as the sinuses related to aortic artery, the ligaments and muscle of Valsalva. In otology, he pioneered the study of the anatomy of the ear, dividing it into external, middle and inner ears, with particular interest in the muscles of the Eustachian tube and pharynx. He viewed for the first time the stapes fixation in identifying the otosclerosis. He created the famous Valsalva maneuver, still used in the diagnosis and therapy in various clinical situations. He died in 1723, in consequence of a brain stroke.

### **Final Comments:**

Valsalva was a remarkable anatomist, physiologist, surgeon and pathologist. He provided valuable contributions to otology and other areas. His achievements are still present in our medical practice. We consider to be worthy for the newly doctors to know a little about Valsalva's history and his work. We hope they remember this great man when applying Valsalva maneuver.

### **Key words:**

Valsalva's maneuver - history of Medicine - Eustachian tube - aortic sinus.

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## INTRODUCTION

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The second half of the 17<sup>th</sup> century and the first half of the 18<sup>th</sup> were characterized as Baroque period (1), when art, poetry and music occupied an eminent position. Due to the Renaissancist thought emerged in the previous centuries, especially in the 17<sup>th</sup>, there were great scientific advances, then that period was regarded as “science era” (1,2). There were two distinct ways of facing factors: rationalism and experiment. Both led to the development of modern scientific thought or scientific method, as better known (1). The 17<sup>th</sup> century could be considered as a convergence of changes occurred during Renaissance and Modern Age. Contributions of such as Bach, Copernicus, Galileo, Newton and Descartes enriched such period (2,3)

Despite all that progress, doctors’ reputation was degenerated. They were targets of comical comments. Even Molière, a great French play writer, used ridiculed the medical profession (4). In fact, doctors used to live a modest life, assisting thousands of patients on a day in order to get enough to survive, due to the low price charged. As “men of science”, they could not advertise their services, and they never lacked work because people of all social classes were affected with variola, syphilis, leprosy, plagues, puerperal fever and German measles (3).

In that period we can mention the figure of Antonio Maria Valsalva. An Italian honorable doctor. The target of this study is to report his life and his contributions to medicine, especially those regarding otorhinolaryngology.

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## REVIEW AND DISCUSSION

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Antonio Maria Valsalva was born on June 16<sup>th</sup>, 1666 in Imola – Italy to a well-to-do family. He was the third of eight children born to the goldsmith Pompeo Pini. His mother was Catarina Tosi, and the name Valsalva came from the location of his grandfather family castle (5,6,7).

He was educated by the Jesuits in the humanities, mathematics, and natural sciences, arousing his interest in animal morphology and entomology (5). These studies called him to Medicine. He decided to move and study at the Bologna University, recognized as the oldest in the world and regarded as *Alma Mater Studiorum* (9).

There, he studied Philosophy with Lelio Trionfetti (Giovanni Battista Trionfetti, 1656-1708), Mathematics with Pietro Mengoli (1625-1686), and Geometry with Rodelli. All of them had great reputation at the time (8). Valsalva may be considered a Galilean through Giovanni Alfonso Borelli (1608-1679). The Medical School of the

University of Bologna had its beginning around 1063. The title “Professor” arises in 1170, and was only conceded by the clergy, having its start from 1179. The city statutes for medicine school date from 1378.

Above several names, Marcelo Malpighi (1628-1694), founder of histology, a respected professor at Bologna University was one of Valsalva’s teachers. Marcelo made use of the microscope to study capillaries of the pulmonary alveolar-capillaries; corpuscle of Kidney and spleen; mucous bodies and epidermoid follicles. Also, made his contributions on fauna and flora (9,10). When at the Bologna University, Valsalva was fortunate of being taught by illustrious teachers. Malpighi, who introduced him to anatomy, was one of them. It is interesting to report the early empathy between them (9). From the beginning Malpighi respected Valsalva, who became his favorite pupil and who greatly admired his teaching methods, being clear and objective (6,10).

On June 10<sup>th</sup>, 1687, at the age of 21, Valsalva became a doctor in Medicine and Philosophy (7), by defending the dissertation *Sulla superiorità delle dottrine sperimentali* (5) in accordance with his principles. During his first years as a doctor, Bologna had been devastated by plagues, and because of his praiseworthy graduation, he was appointed Inspector of Public Health in Bologna. Soon afterwards became known and respected for having applied suitable and fair procedures. Years later, when there was an epidemic among royal settings, the senate of Bologna set him in charge of containing it (6,7,11,12).

Valsalva was highly devoted to his scientific researches, and such passion made him go deeply into his experiments. So deep that he tasted the acid-like serum produced by gangrene, and its extreme sourness irritated the papillae of his tongue for an entire day (6).

He was introduced to the roll of Bolognese doctors and, with Santi Giorgio, Domenico Guglielmi (1655-1710), Ippolito Francesco Albertini (1662-1746) and Giacomo Beccari (1682-1766), started to attend scientific meetings at Eustachio Manfredi’s house (1674-1739), where they founded *Accademia degli Inquiti* (11,13). Due to his remarkable and respectable observations during the local medical meetings, he became known, what led him to be assigned as Professor of Anatomy at the Bologna University in 1694 (14). Ten years later, he was elected President of Science Academy (7).

His most famous work, *De aure humana tractatus* (The Study of Human Ear) was published in 1704 (15,16,17). This study reports his 16 years of experience with more than thousand dissected corpses, especially the ears. He was a pioneer and the first otology physician and the most

remarkable anatomist of his time. His work was published in Italian and German languages in several universities in the main European cities (8,11,12,13). He was the first to clearly describe the anatomy, physiology, and pathology of the ear, and also to establish its division into internal, middle, and external parts, being used up to the present time (13,14,16,17). He was particularly interested in the middle and internal ears and in muscles of the hearing tube and the pharynx (17). In fact, Valsalva was the founder of anatomy and physiology of the ear. He is owed the investigations on activities of the eardrum, of the middle ear ossicles, and of the semicircular canals. He investigated the muscles of the external ear, disregarded by all researchers before him. He also described a method of inflating ear with in order to ease deafness and heal suppurations (17), which is known as Valsalva's maneuver. *De aure humana tractatus* was devoted to the senate of Bologna that showed their gratefulness by providing funds to his researches (17). The book was considered a classic for more than a century (18).

Valsalva's maneuver, through coordination of muscle movements, consists of expiratory force with nose and mouth closed, by sealing vocal folds and glottis for 10-20 seconds. Pressure rises inside hearing tubes. If tubes are permeable, the air will be forced into the middle ear (15,17). This maneuver can be either spontaneous as coughing, defecating or induced (19). The same maneuver was originally used to remove foreign bodies to improve hypoacusis. Surprisingly, it seems that it has already been performed by Arabian physicians in the 9<sup>th</sup> century (13,20), and it is extensively applied in modern medicine to test permeability of the hearing tubes.

It is also applied to investigate hernias of the abdomen wall or vascular abnormalities such as varicocele. Regarding cardiology, normal physiological response to Valsalva's maneuver is divided into four phases: Phase I is associated with transitory raise of systemic blood pressure; it occurs early and rapidly, noticed at examination and does not have clinical importance; Phase II occurs late at forced expiration, by reducing the venous return of blood, the blood pressure, the pulse pressure and causing reflexive mild tachycardia. In this phase, the intensity of abnormal heart noises (third and fourth) and of the aortic and pulmonary systolic murmurs is reduced; systolic murmurs of hypertrophic cardiomyopathy are increased. Phase III, after forced expiration stops, a sudden and transitory fall of blood pressure occurs with an increase of venous return of the blood. The intensity of murmurs of the atrium and right ventricles is increased. - Phase IV, 10-20 seconds after forced expiration stopping, it is observed an increase on systemic blood pressure (bounce) and reflexive bradycardia (slow heartbeat) may increase brief abnormal heart noises and murmurs (21).

Valsalva's maneuver still assists clinical exam by providing rich details and information. However, it has become less important to heart diagnosing due to the advances of Doppler echocardiography. Valsalva's maneuver or massage of carotid sinus can be a therapy method during fast heart rate outbreaks (tachyarrhythmia); for increasing vagus tone (phase IV), they help on diagnosing and even to cease focal atrial tachycardia (22).

Valsalva's maneuver has conquered traditional medicine environment and nowadays is important in fields as diving for instance, where it is used to compensate a progressive increase of the water pressure from outside avoiding middle ear barotraumas in divers. Pilots should also be grateful for such a useful maneuver that also equalizes middle ear with air pressure by forcing air flow through hearing tube, especially when landing, because air pressure becomes greater, and that will cause barotraumas. Would Valsalva ever imagine such amplitude through time his discovery would achieve, and even been known by name?

Regarding Otorhinolaryngology field, he coined the term Eustachian tube and described its function and muscles (6,17). Bartolomeo Eustachio (1513-1574) (23) was an Italian anatomist. His writings comprise references to hearing tube and description of tensor and stapedial muscles of the tympanum. It was the first accurate publication on hearing tube anatomy, although that had been mentioned by Alcmeon de Crotona in 400 B.C. (23). He believed that Eustachian tube allowed goats to breathe through ears as through nose (21). Eustachian discovery of connection between middle ear and pharynx would have inspired Shakespeare to write his tragedy Hamlet, in which the father king would have been ear-poisoned murdered, as his own ghost reveals Hamlet that. Claudius, Hamlet's uncle, would have poured hyoscyamus niger into the king's ear and assumed the throne. Another possibility of ear poisoning was discovered during the 16<sup>th</sup> century, in Italy, based on the information of a possible direct absorption of some substance by the ear (6). Valsalva also related the connection between mastoid cells and tympanic cavity and made observations on physiology and pathology of ear processes (6,17). Regarding rhinology, Valsalva showed that epistaxis could be controlled by digital pressing on the caudal portion of the nasal septum (24).

He also performed dissections to analyze the aortic artery, the suprarenal gland and colon. He was an anatomist, pathologist, physician and a remarkable surgeon; worked in hospitals in Bologna for more than 25 years. When still young, he realized the importance of nephrectomy when successfully performed on dogs for tumors dissection. He used to disagree with injury cauterization, by believing

healing by second intention. He also performed activities regarding ophthalmology, vascular surgery and tumor; is particularly remembered by surgical therapy and manipulation of the aneurysms (25); designed tool widely used even after his time (12) and reported that motor paralysis, after cranial traumatism, occurred on the contralateral side to brain injury (6).

He also acted in psychiatry (5) and was the first one to support that psychiatric patients required humanitarian treatment to help healing (7). This observation came much earlier than the Vincenzo Chiarugi's (1759-1820) and Philippe Pinel's (1745 - 1826) (26). He considered craziness and insanity similar to organic diseases (263).

In 1714, his observations on otosclerosis were enormously positive, though for the first time in history an expert has described ankylosis of the stapedio during dissection process and related that to deafness of the dead patient (16,27).

As Malpighi, Valsalva was also highly respected by his students. His anatomy lessons were looked forward to. And due to his high position and following his master's behavior, he was always watching who, from his students, would be the next to contribute for medicine development. Giovanni Batista Morgagni (1682-1771) (8) was his favorite pupils among all. And needless to say that Valsalva had great influence on his science career.

In 1740, Morgagni published many of Valsalva's works. One of them was an anatomoclinical study that comprises *De sebidus et causis morborum* (by Morgagni) (28), which has numerous Valsalva's contributions. Valsalva had the opportunity to demonstrated his serious behavior towards his principles when was chosen by the University to appraise Morgagni's first essay titled as *Adversaria Anatomica*. He was exhaustively questioned by Valsalva, who wished to achieve a precise conclusion, as the essay would be published as a book. He said "I am as I am; I like Morgagni a lot, and also value the truth" (28).

Domenico Felice Antonio Cotugno (1736-1822) was another of his followers, although did not meet him personally. In 1761 writes *De aquaeductibus auris humane internae*, which was based on and a sequence of Duverney's and Valsalva's work, preceding Helmholtz's. It describes the vestibule, semicircular canals and the cochlea by showing the existence of labyrinth fluid and formulating the theory of audition and resonance sound. Cotugno in 1774 discovered the cerebrospinal fluid.

Besides all his investigations on illustrative anatomy, Valsalva gathered along his life pathological findings encountered on sick patients who arrived in the autopsy

room. In 1723, the year of his death, all that gathered material was trusted to Morgagni by Bologna University and it became the basis for *De sebidus*, in which half of cases were by Valsalva. Valsalva's studies were basically surgical types, differing from Morgagni's whose cases derived from internal medicine (25).

Morgagni also left his contributions through specimen dissection. The exchanged respect between Valsalva and Morgagni was known by everyone and the signs of the master are present in every piece of Giovanni's work, and he states: "There is no one; there is nothing ahead of him and few to be compared to him". (7,28)

He made important observations (6,17,29) as:

- Petit's sinus, also Morgagni's sinus or Valsalva's Sinus that contributed to the initial anatomical studies by François Pourfour du Petit (1664-1741), who was a French anatomist, physiologist and surgeon (6). It is the space between superior aspect of each of the semicircular cusps of aortic valve and the dilated portion of the wall of the ascending aorta. The coronary arteries arise from two of those sinuses.
- Valsalva Antrum or mastoid antrum is a cavity in the petrous portion of the temporal bone.
- Valsalva dysphagia, described in *De aure humana tractatus*. Bologna, 1704
- Valsalva's ligament attaches the auricle to the side of the head.
- Valsalva's muscle consists of a band of vertical muscular fibers on the outer surface of the tragus of the ear, innervated by the temporal branch of the facial nerve

On April 22, at the age of 43 Valsalva married Elena Lisi, the seventeen-year old daughter of a noble Bolognese senatorial family; they had six children, three of whom died young. (8,11,12,13,19,30). His late marriage was perhaps due to his career devotion.

Valsalva started feeling ill early, losing his sense of smell. In an afternoon, in Venice, when discussing his favorite topic with Morgagni suddenly begin to present dyslalia, by speaking few words with trouble, which Morgagni was not able to understand (5,30). This incident lasted few hours and based on his previous studies on physiopathology of cerebrovascular accident, he was able to know what had happened. Two year later, on February 2, 1723, at the age of 56, Antonio María Valsalva passed away of brain stroke or apoplexy (6,30).

His portrait can be seen in the *ball* at Bologna University (picture 2). It is an oval, stone-carved medallion by Angelo Piò (1690 – 1770) and by a nameless and rough farmer. It truly follows the rigorous and solen style of the artist, typically baroque (9).

Valsalva's corpse is buried in *San Giovanni* church – Bologna. His family donated his anatomical specimen's collection to be used for educational purposes to the Science Institute, founded in 1711. Such material possibly inspired the artists as Ercole Lelli and the Manzolini's in their works with wax molding. This anatomical collection comprises heart, lung sculptures which are exposed at Museum of Anatomy (5).

## FINAL COMMENTS

Valsalva was a remarkable anatomist, physiologist, pathologist and surgeon; a noted doctor; an untiring researcher and a persuasive master, though he regarded his major activity to anatomy. He worked arduously along all his life even after becoming ill. He contributed to medicine, especially to Otorhinolaryngology field. His discoveries are present up to the modern days. We curiously wonder the reason modern doctors hardly know his history and value his discoveries. We wish they would remember of this notable figure next time when making use of Valsalva maneuver.

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