

The Scientific Legacy of Antonio Maria Valsalva (1666–1723): An Anatomist's Enduring Contributions to Medicine – A Medical History Study*

Antonio Maria Valsalva'nın (1666–1723) Bilimsel Mirası: Bir Anatomistin Tıbbı Kalıcı Katkıları – Bir Tıp Tarihi Çalışması

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ABSTRACT

Antonio Maria Valsalva (1666–1723) was a prominent Italian anatomist, surgeon, and physiologist whose contributions epitomize the revolutionary essence of early modern medicine. His seminal work, *De aure Humana Tractatus* (1704), systematically described the anatomy and physiology of the ear and thereby laid the foundation for the field of otology. In this paper, he presented the Valsalva maneuver-an expiratory procedure for equalizing middle ear pressure that remains extensively utilized in otolaryngology, cardiology, and neurology. In addition to his contributions to otology, Valsalva made significant advances in cardiovascular anatomy. This study employs qualitative document analysis, utilizing primary sources such as Valsalva's writings and Morgagni's publications, alongside secondary historiographical accounts, to contextualize his contributions within the wider intellectual framework of the Scientific Revolution and Enlightenment medicine. It further examines the dissemination of Valsalva's concepts throughout Ottoman medical literature, emphasizing the cross-cultural aspects of his impact. Valsalva's influence persists not just via medical eponyms associated with his name but also through his humanistic perspective of medicine as a field rooted on observation, inventiveness, and compassion. Over three centuries posthumously, his contributions persist in influencing clinical practice, exemplifying how the ideas of a singular anatomist may resonate across generations of medical study. This historical analysis demonstrates that Valsalva's contributions extended beyond isolated anatomical discoveries and played a pivotal role in shaping observation-based, humane, and interdisciplinary medical practice. The findings underscore the importance of integrating historical perspectives into contemporary medical education, particularly to foster an appreciation of ethical sensitivity, clinical observation, and methodological rigor rooted in early modern medicine.

Keywords: Antonio Maria Valsalva, History of anatomy, Otology, Valsalva maneuver, History of Medicine

ÖZ

Antonio Maria Valsalva (1666–1723), erken modern tıbbın dönüştürücü ruhunu en iyi şekilde yansıtan seçkin bir İtalyan anatomist, cerrah ve fizyologdur. Onun çığır açan eseri *De aure Humana Tractatus* (1704), kulağın anatomisini ve fizyolojisini sistematik olarak tanımlayarak otoloji alanının temellerini atmıştır. Bu çalışmada tanıttığı "Valsalva manevrası" – orta kulak basıncını dengelemeye yönelik ekspiratuvar bir teknik – günümüzde hâlen otolaringoloji, kardiyoloji ve nörolojide yaygın olarak kullanılmaktadır. Valsalva, kulak burun boğaz alanındaki katkılarının yanı sıra, kardiyovasküler anatomi alanında da önemli ilerlemeler kaydetti. Bu çalışma, nitel bir doküman analizi yöntemiyle Valsalva'nın yazıları, Morgagni'nin yayımları ve ikincil tarih yazımı kaynaklarına dayanarak onun katkılarını Bilimsel Devrim ve Aydınlanma tıbbı bağlamında değerlendirmektedir. Ayrıca, Valsalva'nın fikirlerinin Osmanlı tıp literatürüne aktarımını inceleyerek etkisinin kültürler arası boyutlarını vurgulamaktadır. Valsalva'nın kalıcı mirası, yalnızca adını taşıyan tıbbi terimlerde değil, aynı zamanda gözleme, yeniliğe ve şefkate dayalı insancıl tıp anlayışında da yaşamaktadır. Ölümünden üç yüzyıl sonra dahi çalışmaları klinik uygulamaları şekillendirmeye devam etmekte ve tek bir anatomistin katkılarının tıp bilimi nesiller boyunca nasıl yankı bulabileceğini göstermektedir. Bu tarihsel analiz, Antonio Maria Valsalva'nın katkılarının yalnızca belirli anatomik keşiflerle sınırlı olmadığını, aynı zamanda gözleme dayalı, insancıl ve disiplinlerarası bir tıp anlayışının gelişiminde belirleyici bir rol oynadığını ortaya koymaktadır. Çalışmanın bulguları, tıp tarihi çalışmalarının çağdaş tıp eğitimi ve etik düşünceye katkı sağlayacak biçimde müfredatlara daha fazla entegre edilmesinin önemine işaret etmektedir.

Anahtar Kelimeler: Antonio Maria Valsalva, Anatomi tarihi, Otoloji, Valsalva manevrası, Tıp tarihi.

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Introduction

Antonio Maria Valsalva was an Italian anatomist, surgeon, and physiologist whose contributions at the turn of the 17th and 18th centuries established the foundations of contemporary medicine. Antonio Maria Valsalva was born in 1666 in Imola, Italy, and came of age during the scientific revolution, a period in which traditional Galenic doctrines were increasingly challenged by empirical investigation. Under the guidance of Marcello Malpighi at the University of Bologna, Valsalva adopted the burgeoning experimental approach in anatomy and physiology^{1,2} (**Fig 1**). His career emerged at a period of significant transformation; notably, the year of his birth(1666), is recognized as an annus mirabilis in science, symbolizing the era's fresh discoveries and intellectual vigor.³



Fig 1. Antonio Maria Valsalva, from the National Library of Medicine.

On June 10, 1687, Antonio Maria Valsalva obtained his doctorate in medicine and philosophy by defending his thesis entitled "*Sulla superiorità delle dottrine sperimentali*" (On the Superiority of Experimental Doctrines). Subsequent to his graduation, Valsalva dedicated himself to medical practice, pedagogy, and scientific inquiry.³ He started his career in Bologna as an Inspector of Public Health and then became Professor of anatomy at the University of Bologna in 1705.⁴

In this context, Valsalva distinguished himself via painstaking observation, audacious innovation, and a compassionate attitude to therapeutic treatment. Valsalva is well recognized for the "Valsalva maneuver," a forced expiration method executed against a closed airway. This procedure initially detailed in his 1704 book on the ear, continues to be a prevalent test in otolaryngology and cardiology today. However, Valsalva's contributions encompass much more than this solitary eponym. He produced substantial discoveries in cardiovascular anatomy. He provided a detailed description of the aortic sinuses, later known as the sinuses of Valsalva.⁵ Beyond this contribution, he conducted pioneering investigations of the ear, pharynx, and nervous system. He pioneered surgical advances and research methodologies that were avant-garde, including the ligation of arteries to control hemorrhage (in lieu of cautery)² and He conducted innovative physiological investigations, including the direct examination of purulent material to assess its properties.^{2,5} Moreover, Valsalva championed the humane treatment of individuals with mental illness, perceiving psychiatric problems as physiological ailments rather than issues of demonic possession or moral deficiency. This comprehensive and compassionate perspective was remarkable during a time when such patients were frequently overlooked or abused.

This article aims to analyze Valsalva's scientific legacy within its historical framework, focusing on his contributions to anatomy, physiology, and surgery, as well as their influence on medical theory. We utilize both primary materials (Valsalva's original papers and letters) and secondary studies from the history of medicine. We also examine historiographical viewpoints about how subsequent researchers have understood Valsalva's contribution to the advancement of medicine and investigate the reception of his ideas outside Italy, particularly within the Ottoman medical tradition. Positioning Antonio Maria Valsalva within the expansive context of medical history reveals how his contributions epitomized a pivotal period and elucidates the reasons for his lasting presence in contemporary medical language and practice.

Materials And Methods

This research constitutes a medical history investigation utilizing document analysis methodology. The document analysis approach is commonly utilized in medical history, especially in biographical studies and the interpretation of historical contributions. Document analysis is a qualitative research methodology that enables the systematic evaluation of written materials to extract information about specific phenomena or individuals.⁶ In medical history, document analysis depends on the assessment of archival sources, original manuscripts, contemporary reports, and biographical records, compared with secondary historiography.⁷ Research materials were collected between March 2005 and May 2025.

In this study, the primary sources included Antonio Maria Valsalva's *De Aure Humana Tractatus* (1704)⁸, his student Giovanni Battista Morgagni's *Epistolae Anatomicae XVIII* (1740)⁹, as well as contemporary biographical literature. Furthermore, letters and observational records from the period were examined. Secondary sources consisted of monographs and articles on medical and anatomical history.² These sources were identified through searches in PubMed, JSTOR, Scopus, and Google Scholar databases using the keywords "Valsalva," "history of anatomy," "Valsalva maneuver," and "Antonio Maria Valsalva."

Result and Discussion

The collected data were classified chronologically and assessed according to the principles of document analysis. This approach involved the presentation of Valsalva's biographical trajectory and his scientific accomplishments.

The document analysis process comprised four stages:

Data collection: Systematic search of primary and secondary sources.

Critical review of data: Assessment of the reliability and contextual accuracy of the sources.¹⁰

Content analysis: Classification of Valsalva's contributions (otology, cardiovascular anatomy, surgery, neuropsychiatry) under themes associated with the ethical understanding of the period.

Interpretation: Reconstruction of findings within their historical and ethical context.¹¹

Early Life and Education in Bologna

Antonio Maria Valsalva was born in 1666 in Imola, Papal States (present-day Italy), into an affluent family. His father, Pompeo Pini, was a jeweler who adopted the surname "Valsalva" from the family's origin.¹² In his youth, Antonio had a classical education in a Jesuit institution, focusing on the humanities, mathematics, and natural sciences.² This extensive early education ignited his fascination with natural philosophy and anatomy. In the mid-1680s, Valsalva matriculated at the University of Bologna, one of Europe's oldest and most prestigious medical institutions, recognized as the *Alma Mater Studiorum*. He studied philosophy under Lelio Trionfetti and mathematics under Pietro Mengoli, while his most significant influence came from his apprenticeship with Marcello Malpighi (1628–1694).¹² Malpighi, an innovative microscopist and the

progenitor of histology, conveyed to Valsalva the significance of empirical observation and dissection. A relationship of strong mutual respect developed between mentor and pupil: Malpighi recognized Valsalva's talent and supported his anatomical work, while Valsalva, in turn, held deep admiration for Malpighi's clear and evidence-based pedagogical approach.²

In 1687, at the age of 21, Valsalva earned *magna cum laude* (with great distinction) with dual doctorates in medicine and philosophy. Fittingly, his graduation thesis was titled "On the Superiority of Experimental Doctrines" (*Sulla Superiorità Delle Dottrine Sperimentali*), reflecting his alignment with the new scientific methods.¹³ His entry into medical practice was marked by dramatic circumstances. In 1687, Bologna experienced a plague epidemic, which led to his immediate appointment as Inspector of Public Health for the city. In this position, Valsalva garnered a reputation for astute clinical judgment and efficacious public health interventions. He allegedly attended to the Governor of Bologna during the outbreak, impressing local officials with his expertise. These initial encounters not only assessed Valsalva's medical proficiency but also showcased his dedication to public service.^{2,4,14}

Academic and Surgical Career in Bologna

Subsequent to the plague epidemic, Valsalva shifted to academic and hospital endeavors in Bologna, the city that would become the focal point of his career. In 1695, he was designated as a staff surgeon at the Ospedale di Sant' Orsola, also referred to as the Hospital of the Incurables. He refined his surgical procedures and pursued extensive anatomical study, frequently doing dissections on cadavers to connect pathological discoveries with clinical manifestations. Valsalva's commitment and findings quickly received broader acknowledgment. In 1705, he was named Professor of Anatomy at the University of Bologna, succeeding or collaborating with esteemed colleagues from the Bologna medical faculty. A few years later, he was appointed President of the Bologna Academy of Sciences (Istituto delle Scienze, also known as the Clementine Academy), a position that reflected his prominence within the scientific community.¹²

Bologna in the late 17th century was a dynamic center of medical innovation, sometimes termed the "Bologna School" of anatomy and pathology. Valsalva became a fundamental component of this environment. He co-established, among colleagues like as Eustachio Manfredi and Domenico Guglielmi, a regional scientific organization called the *Accademia Degli Inquieti* (Academy of the Restless). These assemblies facilitated vibrant dialogues and experimental presentations. Valsalva's lectures at the academy and at medical conferences were widely praised for their accuracy. They focused on emerging surgical methods and careful anatomical analysis. His increasing prominence resulted in several accolades. He earned titles such as *Incisor Generalis Anatomiae* (General Anatomical Dissector) in 1697 and *Publicus Professor et Ostensor Anatomiae* (Public Professor and Demonstrator of Anatomy) in 1705.

He was subsequently elected an honorary member of the Royal Society of London, among other accolades. He was offered the position of personal physician to Pope Clement XI.

He declined the offer in order to remain in Bologna and fulfill his academic responsibilities.³

Throughout his career, Valsalva fostered a strong rapport with his students and protégés. Among them, Giovanni Battista Morgagni (1682–1771) emerged as the most renowned, having trained under Valsalva in Bologna. Morgagni had profound affection for his mentor and subsequently compiled and published all of Valsalva's works, accompanied by a definitive biography, in 1740. This posthumous volume, *Epistolae anatomicae XVIII* (1740), guaranteed that Valsalva's discoveries would be disseminated to a wide European readership. Morgagni's seminal publication, *De Sedibus et Causis Morborum* (1761), is based on the systematic correlation of clinical cases with postmortem findings. The work extensively drew upon cases and anatomical specimens from Valsalva's collections. In fact, roughly half of the 640 cases in *De Sedibus* were based on observations originally made by Valsalva. Consequently, Morgagni's endeavors facilitated Valsalva's

significant indirect impact on the evolution of pathology and the clinicopathological approach during the 18th century.^{15,16}

Outside of Bologna, Valsalva's skills was in high demand across Italy. Certain reports indicate that he spent time in Naples during the latter part of his career in the Ospedale degli Incurabili, while Bologna remained his principal base.⁵ He married Elena Lisi in 1709 and had several children, balancing family life with his intense professional Schedule. Colleagues characterized him as a “gentleman” in disposition—benevolent, principled, and profoundly dedicated to his patients and pupils. Valsalva frequently provided pro bono medical care to indigent patients and supported promising students, including two household attendants whom he educated and trained as surgeons. His humanitarian disposition fostered strong relationships with his peers and may have helped persuade more traditionally minded physicians to adopt new experimental and observational approaches.²

Valsalva is frequently positioned within the lineage of prominent Bolognese anatomists and pathologists in history. He is regarded as the connection between Malpighi (his mentor) and Morgagni (his student), establishing a continuous in the progression of anatomy and pathology at the University of Bologna. Malpighi introduced microscopic examination to anatomy; Valsalva expanded empirical techniques to gross anatomy and clinical correlation; Morgagni subsequently integrated these methodologies to establish contemporary pathological anatomy. Each constructed atop the preceding one. The 2023 study suggests that Valsalva's diligent work "established the foundations of pathological anatomy" by incorporating pathological alterations into precise clinical data.⁵ In this view, Valsalva's notebooks (inherited and published by Morgagni) were a direct precursor to *De Sedibus*, one of the foundational texts of modern medicine.²

Illness, Death, and Posthumous Legacy

During his later years, Valsalva encountered personal health difficulties. He experienced recurrent episodes of bronchitis and pneumonia, and potentially diabetes, as suggested by his documented extreme thirst. In 1721, during a discussion with Morgagni in Venice, Valsalva encountered an episode of *dyslalia* and transitory neurological symptoms. Utilizing his expertise in cerebrovascular illnesses, Valsalva identified them as indicators of a grave situation. The incident may have been a transient ischemic attack or a prelude to a stroke. Approximately two years later, on February 2, 1723, Antonio Maria Valsalva passed away in Bologna at the age of 56.² Contemporaries characterized the etiology as "apoplexy," which aligns with a cerebrovascular accident (stroke) or a similar intracerebral occurrence. His demise deprived the Bologna Medical Community of one of its most distinguished members.

Valsalva was interred in the Church of San Giovanni in Monte in Bologna.¹⁷ Morgagni's publishing of Valsalva's works in 1740 cemented his reputation in medical literature. Colleagues' tributes further affirm his influence. According to Morgagni, Valsalva was regarded as an unparalleled figure of his era, with few contemporaries considered his equals (as cited in van Gijn & Gijssels, 2010). Medical historians subsequently saw Valsalva as a pivotal transitional figure bridging the Renaissance anatomists and the Enlightenment scientific era. In the ensuing sections, we analyze Valsalva's key contributions comprehensively and investigate their significant impact on the evolution of medical knowledge.¹⁸

Major Scientific Contributions and Innovations

Otology and Anatomy of the Ear

Valsalva's most celebrated work, *De Aure Humana Tractatus* (Treatise on the Human Ear) (**Fig 2**), published in 1704, marked a significant advancement in the examination of the ear's anatomy, physiology, and pathology. This extensive volume summarizes 16 years of Valsalva's study on more than a thousand cadaveric

dissections, specifically concentrating on the auditory system⁵. Valsalva was the first to distinctly categorize the ear into three regions: external, middle, and inner ear, establishing the foundation for the emerging subspecialty of otology. Valsalva presented detailed anatomical descriptions of the ear. His work was enriched with illustrations by the artist Francesco Cavazzoni. The structures described included the tympanic membrane, the ossicles of the middle ear, the cochlea, and the semicircular canals, along with their physiological functions.^{3,19} He clarified the mechanics of hearing by illustrating the transmission of sound waves from the eardrum via the ossicular chain to the oval window of the inner ear. He even proposed roles for the semicircular canals; however, the vestibular function would not be validated until much later.^{8,12}

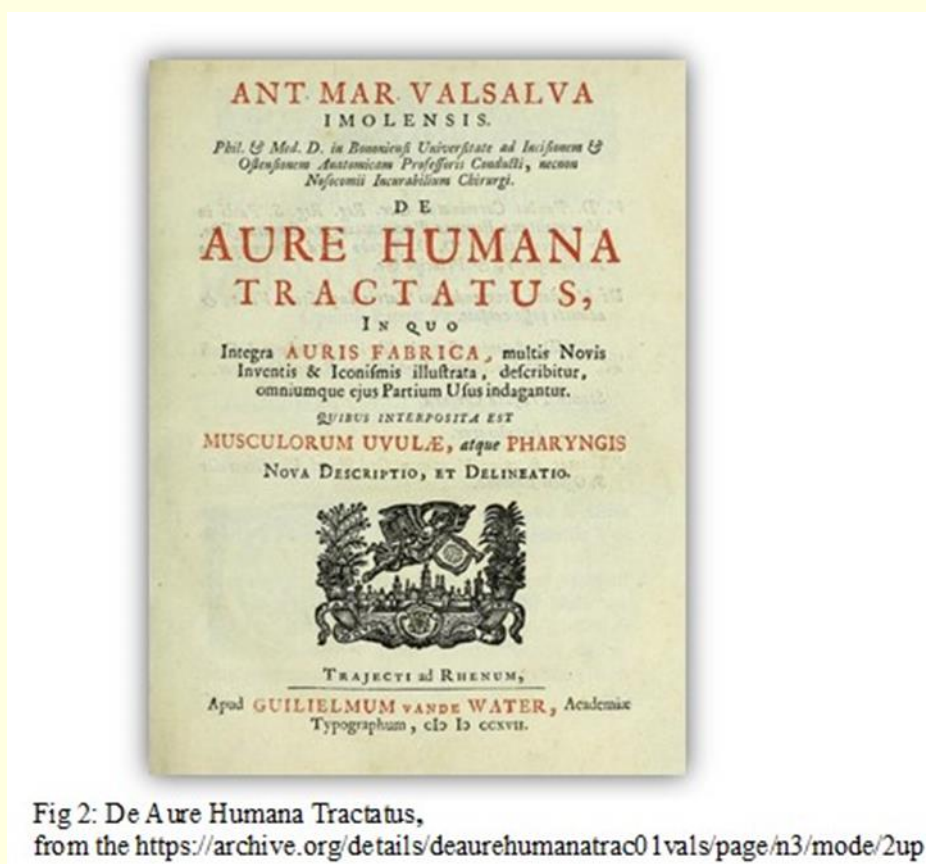


Fig 2: De Aure Humana Tractatus,
from the <https://archive.org/details/deaurehumanatrac01vals/page/n3/mode/2up>

Valsalva examined the Eustachian tube in detail. This structure forms a conduit between the middle ear and the nasopharynx. He introduced the term “Eustachian tube” in honor of the sixteenth-century anatomist Bartolomeo Eustachi, who had first described the structure. Valsalva was intrigued by the tube's function in equilibrating air pressure and delineated its two segments (bony and cartilaginous) along with the muscles responsible for its opening. He provided an early description of the muscle responsible for dilating the Eustachian tube, later identified as the *tensor veli palatini*. To assess the patency of the Eustachian tubes and the mobility of the tympanic membrane, Valsalva developed a technique involving forceful exhalation with the nose and mouth occluded, aimed at propelling air into the middle ear. The Valsalva maneuver is a simple clinical method used to assess Eustachian tube patency. When the tubes are patent, the maneuver induces outward bulging of the tympanic membranes, thereby indicating their openness. Valsalva initially proposed this procedure to eliminate middle ear effusions and alleviate ear discomfort in divers or anyone undergoing pressure fluctuations. This approach remains essential in otolaryngology and other fields, as elaborated in a subsequent section.^{3,20,21,22}

In addition to gross anatomy, Valsalva investigated the intricate structures and pathological states of the ear. He recorded the location of ceruminous glands in the auditory canal and their function in the production of

cerumen. In one instance, he perceptively identified a patient's 12 year hearing loss as resulting from cerumen impaction rather than senescence; Valsalva achieved a resolution by extracting a hardened wax plug from the tympanic membrane. He investigated the ramifications of tympanic membrane perforation, noting in canine studies that a perforated eardrum resulted in transient hearing loss rather than total deafness, and that auditory function was reinstated when the membrane recuperated. These trials illustrated the eardrum's ability to regenerate and function, as well as the significance of binaural hearing for sound localization (dogs with one ruptured eardrum experienced challenges in discerning the direction of sound).^{3,21,23}

Valsalva's research also encompassed ear pathology. He was one of the initial individuals to delineate otosclerosis, a condition characterized by aberrant osseous proliferation in the middle ear, resulting in stapes fixation and auditory impairment. In cadaveric examinations, he saw ankylosis of the stapes and accurately linked it to deafness in those subjects. These findings anticipated our contemporary comprehension of conductive hearing loss. He also delineated an air space within the mastoid segment of the temporal bone (the cavity linked to the mastoid air cells), which was subsequently designated as the antrum of Valsalva (often referred to today as the mastoid antrum). He acknowledged the therapeutic importance of this area concerning mastoiditis and the dissemination of ear infections to bone.^{8,12}

Valsalva provided a comprehensive description of the muscles engaged in deglutition within the pharynx. He articulated the palatal and pharyngeal musculature with such accuracy that a swallowing disease was subsequently named "Valsalva Dysphagia." This word probably originated from his descriptions of dysphagia, but it is not frequently employed in contemporary discourse. Regarding the external ear, he identified a small muscle on the tragus (the protrusion at the opening of the ear) -now known as "Valsalva's Muscle" or the *Musculus Tragicus* - which assists in tensing the tragus. He also delineated the "Valsalva ligament," fibrous bands that link the auricle to the skull, which assist in maintaining the external ear's position.^{3,21,22,23} **Table 1** summarizes these and other anatomical terms named after Valsalva.

Table 1. Key Anatomical Eponyms and Terms Associated with Antonio Maria Valsalva

Eponymous Term	Description and Significance
Valsalva maneuver	Forced exhalation against an occluded airway (closed glottis and nostrils), resulting in elevated intrathoracic pressure. Initially articulated by Valsalva to expand the middle ear and assess Eustachian tube permeability; presently employed in diverse medical applications (ear pressure equalization, vagal stimulation for arrhythmias, etc.).
Sinuses of Valsalva	The three aortic sinuses (dilations) located at the base of the ascending aorta, positioned superior to the aortic valve cusps (right, left, and posterior non-coronary sinus). Initially characterized by Valsalva and subsequently titled in honor of Morgagni after his death. These sinuses originate the coronary arteries (right and left) and provide adequate valve closure.
Valsalva's antrum	Aerated space within the mastoid segment of the temporal bone (mastoid antrum) that connects with the air cells of the middle ear. Significant in the dissemination of middle ear infections; identified by Valsalva during his auditory dissections.
Valsalva's ligament	A ligament connecting the auricle (pinna) of the external ear to the lateral aspect of the skull. Offers structural reinforcement to the auricle.
Valsalva's muscle	Also known as the <i>musculus tragicus</i> , a tiny vertical strip of muscle fibers located on the tragus of the external ear. Innervated by the facial nerve, it facilitates the movement of the tragus.
Valsalva's teniae	Another historically used term for the <i>teniae coli</i> , the three longitudinal smooth muscular bands on the surface of the colon. Valsalva examined intestinal anatomy; the title acknowledges his meticulous depiction of these structures.
Valsalva (aortic) aneurysm	A particular kind of aneurysm affecting an aortic sinus (often the right or non-coronary sinus) characterized by a thin-walled outpouching. The disease is named after Valsalva because of the region he defined, known as the sinus of Valsalva, despite not being identified by him directly.

Table 1, delineates the anatomical features and terminologies attributed to A.M. Valsalva, illustrating the extent of his contributions. Numerous of these phrases persist, highlighting his enduring influence on medical terminology.^{12,13,14,20,24}

Perhaps most impressively, Valsalva's *De Aure Humana* was so comprehensive that it remained a standard reference for over 150 years.⁵ For generations, physicians throughout Europe studied ear anatomy and illnesses from Valsalva's book, which essentially founded otology as a scientific subject. Contemporary historians appropriately recognize Valsalva as a trailblazer in otology, being the inaugural physician to extensively examine the anatomy and physiology of the ear.¹² His research on the ear illustrates his integration of meticulous anatomical dissection with clinical acumen to enhance understanding in a previously neglected domain.

Cardiovascular Discoveries

While Valsalva's principal interest was in the anatomy of the head and neck, he also significantly contributed to cardiovascular anatomy and pathophysiology. His name is indelibly associated with the aortic sinuses, as seen. Valsalva has a profound interest in the anatomy and physiology of the cardiac valves and major arteries. Expanding upon the work of previous anatomists such as Giulio Cesare Aranzi, who identified the nodules in the core of the aortic valve cusps, Valsalva examined the mechanics of aortic valve closure. He recognized the three distended pockets in the aortic root and observed that as the aortic valve cusps close, these sinuses fill with blood, facilitating appropriate coaptation of the valve.²⁵

The right and left coronary arteries originate from two of these sinuses, whereas the posterior sinus lacks a coronary artery (hence termed the “non-coronary sinus”). Morgagni published Valsalva's meticulous description of these structures posthumously, designating them as the “sinuses of Valsalva”. The sinuses are not only architecturally significant for valve function but also clinically pertinent; congenital or acquired aneurysms of a sinus, known as Valsalva sinus aneurysms, are known to develop and have subsequently been identified as a source of heart problems.

Valsalva also investigated vascular pathology. He had a specific interest in thoracic aortic aneurysms. Prior to the contemporary comprehension of atherosclerosis or connective tissue illnesses, Valsalva posited that inflammation of the vascular wall (the adventitia) may compromise the aortic wall, resulting in aneurysm or dissection. This was a progressive effort to elucidate aneurysm development through pathological mechanisms rather than only through genetic inheritance or humoral imbalance. Although constrained by the scientific context of his time, his views suggested that inflammatory damage has a role in vascular disease, a subject currently under investigation today.

As a proficient surgeon, Valsalva implemented enhancements in the surgical care of vascular injuries. He was among the pioneering European surgeons to endorse the ligation of arteries to manage bleeding, as opposed to the prevalent method of cauterizing wounds with heated instruments.¹³ Centuries prior, Ambroise Paré advocated for ligatures in amputations yet, cautery persisted in several surgical communities. Valsalva's application of mild ligation demonstrated his commitment to tissue preservation and the minimization of discomfort during therapy. He acknowledged that using a constrictive ligature on blood vessels after amputations or injuries might attain hemostasis more efficiently and compassionately than cauterizing tissue.^{26,27} This method reduced bleeding and infection risk, aligning with the evolving surgical techniques of the early 1700s and predating widespread acceptance of surgical best practices.

The Valsalva maneuver itself represents another significant addition to cardiovascular physiology, exhibiting crucial hemodynamic implications (elaborated upon in the subsequent section). Valsalva initially delineated the procedure for otological purposes and likely did not anticipate its subsequent application in cardiology.

Nonetheless, 19th-century medics identified that the straining phase of the Valsalva maneuver modifies venous return and cardiac output, serving as a method to assess heart function. In contemporary echocardiography and cardiology, the Valsalva maneuver aids in the diagnosis of certain cardiac disorders, such as distinguishing between kinds of heart murmurs or evaluating autonomic regulation of heart rhythm. Consequently, a concept originating in the anatomical theater was revitalized in the cardiology clinic, exemplifying Valsalva's interdisciplinary influence.

Neurological and Psychiatric Insights

Valsalva's curiosity encompassed the nervous system and the treatment of people with neurological or psychiatric conditions. During autopsy exams, Valsalva was one of the first to observe that brain lesions frequently manifest symptoms on the contralateral side of the body. This condition, termed contralateral neurologic impairment, would subsequently be elucidated through the idea of decussation (the crossing of neural paths). A stroke affecting the right hemisphere of the brain resulting in left-sided paralysis is anticipated; yet, during Valsalva's era, this finding was unprecedented. In his accounts of "Apoplexy" (stroke), Valsalva noted that paralysis or weakness manifested on the side contralateral to the brain lesion identified during dissection. This was a substantial advancement in the localization of cerebral activity and the concept that the brain's hemispheres govern opposing sides of the body, previously known as the "Valsalva Doctrine" of contralateral control.^{28,29}

Valsalva also investigated therapeutic approaches for the acute neurological crises of his era. Recognizing elevated intracranial pressure in strokes, he advocated therapeutic venous cutdowns to alleviate pressure. He specifically proposed incising the jugular vein to alleviate blood from the cerebral region in instances of suspected intracranial hypertension. The rationale was to reduce cerebral congestion by providing an outlet for venous blood, potentially mitigating the effects of apoplexy. This method, a kind of bloodletting, is not employed in contemporary stroke care and shown little effectiveness; yet, it illustrated Valsalva's intention to utilize anatomical-pathological reasoning in therapeutic practices. It also highlights the difficulties encountered by 18th-century physicians in treating strokes, without the advantages of contemporary therapies.

Valsalva's perspectives in psychiatry were notably avant-garde. He saw mental disease as stemming from biological, physiological origins and vehemently condemned the inhumane treatment of the mentally sick prevalent during his day. During the late 17th and early 18th centuries, individuals with mental illnesses in Europe were frequently restrained, subjected to physical abuse, or shown as spectacles. Valsalva pushed for humane care, asserting that these individuals suffered from ailments of the brain or body and should get treatment in hospitals rather than in jails. He reportedly oversaw a mental unit at the Bologna Hospital, where he implemented more compassionate management practices, however specifics are limited. In his works, he prioritized observation and somatic therapies (including nutrition, phlebotomy, or herbal medicines) over exorcism or punitive measures. This humanistic perspective anticipated the subsequent reforms of individuals such as Philippe Pinel and is a reason some scholars attribute to Valsalva a "biopsychosocial" viewpoint prior to its formal recognition. The contemporary focus of psychiatry on dignity and empathy in patient treatment may be traced back to an early advocate in Valsalva.

Collectively, these neurological and psychiatric contributions illustrate Valsalva's expansive perspective as a physician-scientist. He did not confine himself to a singular bodily system, but instead sought to comprehend the interconnected functions of the human organism. This integrated viewpoint, which sought linkages among anatomy, physiology, and clinical practice, was a hallmark of his work.

Research Methodology

Surgical Practice

Antonio Valsalva's scientific accomplishments were supported by his pioneering research methodologies and approaches, which were progressive for his time. During an era when several physicians depended on traditional books or unverified hypotheses, Valsalva was an empirical investigator. He epitomized the early experimental physiologist who contended that direct observation and empirical testing are fundamental to medical knowledge.¹⁴

Anatomical dissection was one of Valsalva's principal instruments. He conducted several dissections on human cadavers and certain animals to delineate the anatomical structures of the body. He meticulously documented the relationship between his dissection findings and patients' previous symptoms and treatments, so engaging in a basic type of clinicopathological correlation. This systematic compilation of case studies and autopsy results contributed to the establishment of pathological anatomy as a scientific subject. Valsalva's systematic incorporation of autopsy findings into clinical observations laid the groundwork for Morgagni's more extensive research a generation thereafter.⁴

In addition to passive observation, Valsalva meticulously devised studies to evaluate physiological functioning. To examine the function of the Eustachian tube and middle ear pressure, he developed the Valsalva maneuver and meticulously recorded its results. To investigate auditory function, he performed controlled tympanic membrane rupture studies in dogs to observe the effects on hearing. These experiments demonstrate Valsalva's use of the scientific method: posing a question (e.g., does a perforated eardrum result in complete deafness?), intervening (perforating an eardrum), and monitoring results (the dog's hearing partially recovers when the membrane heals). This empirical approach was still relatively novel in medicine and exemplified Valsalva's innovative attitude.

Valsalva was willing to push the boundaries of sensory investigation, accepting personal risk to obtain empirical data. In a notable incident, he sampled the exudate from a gangrenous lesion to gain a deeper comprehension of its characteristics³. He stated that the gangrenous pus possessed an exceedingly acrid flavor that rendered his tongue tingling and caused him discomfort for a day. Although this organoleptic method appears unconventional by contemporary standards (and actually subjected him to infection), it illustrates Valsalva's unwavering dedication to direct observation. He gradually lost his olfactory sensitivity, perhaps owing to prolonged exposure to noxious scents and pathogenic substances during dissections. Paradoxically, that loss may have facilitated his ability to examine even more decayed carcasses without the typical repulsion, enabling him to do autopsy "in the most extreme conditions" of decomposition.²

In surgical practice, Valsalva combined inventiveness with prudence. We have examined his implementation of artery ligation for bleeding management. He also developed or improved surgical equipment for numerous operations, with contemporaneous sources attributing to him innovative designs of syringes and probes for ear, nose, and throat (ENT) applications, although detailed documentation of these devices is limited. At the Ospedale di Sant' Orsola, he allegedly conducted experimental surgeries on animals, including the excision of a spleen or kidney, to evaluate the viability of such organ removals. These can be seen as rudimentary precursors to elective splenectomy or nephrectomy. There is conjecture that Valsalva may have conducted similar procedures on people under extreme circumstances, however definitive proof is absent.⁵ It is evident that he was unafraid to pursue innovative surgical interventions for illnesses such as tumors or abscesses that were otherwise lethal. His contemporaries esteemed him as an exceptional surgeon who integrated anatomical knowledge with clinical expertise. Valsalva notably underscored the importance of delicate tissue manipulation and meticulous technique during a period characterized by frequently violent

surgical practices. An illustration from his surgical texts is his emphasis on precise incisions and minimizing tissue damage “avoid injuring the tissues” using crude techniques, as one summary articulates.^{2,3} He was advocating for surgical precision during a period when several practitioners depended on sheer might. This perspective anticipated subsequent surgical approaches aimed at reducing damage and employing aseptic techniques, despite the lack of understanding of asepsis at the time; his instinctive emphasis on cleanliness undoubtedly contributed to a reduction in infection rates.

In essence, Valsalva's methodologies comprehensive dissection, hypothesis-driven experimentation, innovative procedures, and a caring therapeutic ethics – distinguished him from several peers. His methodology illustrated the shift from Renaissance medicine, characterized by scholarly theorists, to Enlightenment medicine, propelled by empirical researchers. It is unsurprising that contemporary researchers characterize Valsalva's period as a “smooth revolution” in medical science, a movement he significantly influenced as both a scientist and humanitarian.

The Valsalva Maneuver: Physiology and Clinical Applications

Any discourse on Valsalva would be incomplete without an analysis of the Valsalva maneuver possibly his most renowned contribution. The conventional Valsalva technique entails an individual forcibly exhaling with the mouth and nose occluded, resulting in elevated pressure inside the thoracic and pharyngeal cavities. Valsalva first proposed this movement to eliminate pus from the middle ear and to equilibrate pressure across the tympanic membrane in instances of otitis or barotrauma. In his treatise, he directed patients to occlude their nostrils and exhale, noting the impact on the tympanic membrane. This straightforward action has since discovered several applications in medicine.

Physiologically, the maneuver causes a well characterized sequence of cardiovascular responses, divided into four phases:

Phase I (Onset of strain): The initial bearing down elevates intrathoracic pressure, which is conveyed to the aorta. This temporarily increases blood pressure when the heart contracts against the elevated pressure, expelling more blood.

Phase II (Continued strain): Prolonged elevated intrathoracic pressure obstructs venous return to the heart, diminishing cardiac output. Blood pressure decreases, frequently resulting in reflex tachycardia as the body attempts to adjust.

Phase III (Release): Upon the abrupt reduction of strain (when the individual ceases exhalation and opens the glottis), intrathoracic pressure rapidly decreases. The aortic pressure temporarily decreases upon the removal of external compression, resulting in a brief episode of transitory hypotension.

Phase IV (Recovery): Blood return to the heart recommences, cardiac output stabilizes, and blood pressure exceeds baseline levels. The carotid baroreceptors detect elevated pressure and initiate a reflex bradycardia during this overshoot.

Clinicians utilize these hemodynamic phases as a straightforward assessment of autonomic function and heart efficiency. An atypical reaction may signify conditions such as autonomic neuropathy or cardiac insufficiency. Although Valsalva did not specify these phases in the 1700s, contemporary physiology has clarified the systemic implications of his technique.^{29,30}

Clinical applications of the Valsalva maneuver today are remarkably broad, testament to its “versatility” as a tool:

Otolaryngology: As Valsalva intended, it is employed to open the Eustachian tubes and equilibrate middle ear pressure. Air passengers, divers, or those with eustachian tube disorders engage in this practice to alleviate ear pain. Commonly referred to as “popping the ears,” it is the primary recommendation for preventing barotrauma. *The Valsalva test* in ENT examinations evaluates tympanic membrane mobility by observing if the drum protrudes during the maneuver.

Cardiology: The maneuver is utilized for both diagnostic and therapeutic purposes. By monitoring alterations in blood pressure and heart rate during a supervised Valsalva maneuver, physicians can acquire insights on cardiac function and autonomic reflexes. Certain heart murmurs exhibit variations in severity with exertion due to modified cardiac volumes, facilitating their recognition. A modified Valsalva technique (reclining with elevated legs during exertion) is a suggested first strategy to resolve bouts of paroxysmal supraventricular tachycardia (PSVT). Elevated intrathoracic pressure activates the vagus nerve (via the baroreceptor reflex), potentially decelerating atrioventricular nodal conduction and frequently terminating the arrhythmia.^{26,27} This is a simple, non-invasive maneuver to slow a rapid heartbeat before resorting to medications.

Neurology: The maneuver aids in assessing specific autonomic nervous system problems. It temporarily elevates intracranial pressure, therefore it is sometimes utilized in neurological assessments or imaging to elicit indicators of spinal cerebrospinal fluid leaks or to expand venous structures. In radiography, telling a patient to “bear down” can improve venous visibility, facilitating the detection of varicosities or herniations.

Detection of Cerebrospinal Fluid (CSF) leaks: In cases of intermittent cerebrospinal fluid (CSF) rhinorrhea, frequently following head trauma or sinus surgery, executing a Valsalva maneuver can elevate intracranial pressure and elicit a discernible fluid leak, so aiding in the identification of the skull base defect.

Other surgical uses: Surgeons may employ a short Valsalva maneuver during surgery to identify bleeding sites, such as post-thyroidectomy, to assess whether venous hemorrhage intensifies with pressure. In anesthesiology, once patients awaken from anesthesia, they may cough or perform a Valsalva maneuver, potentially stressing certain surgical repairs or inducing hemodynamic fluctuations; anesthesiologists remain cognizant of this.

Rescue techniques: The Heimlich maneuver for choking is fundamentally linked; it generates an artificial Valsalva by elevating the diaphragm, so expelling air to dislodge an obstruction in the airway. Although not executed by the patient, it utilizes the similar premise of an abrupt increase in pressure.

The Valsalva maneuver is often safe for healthy persons, however it may provide hazards in specific situations. Acute fluctuations in blood pressure can pose significant risks to people with severe coronary artery disease or those at risk of stroke. Reports indicate that the procedure may induce arrhythmias, syncope, or, in rare instances, rupture cerebral aneurysms when performed with excessive effort. An illustrative case is Valsalva retinopathy, when a rapid increase in venous pressure due to heavy lifting or vomiting (a Valsalva maneuver) results in retinal hemorrhages and vision impairment. In surgical environments, inappropriate use of Valsalva maneuvers, such as prolonged straining during neurosurgery or central line insertion, has resulted in problems including air embolism and pneumocephalus. Consequently, doctors are urged to exercise caution and employ appropriate techniques, particularly in patients with preexisting cardiovascular or neurological susceptibilities.

The Valsalva maneuver has transitioned from a specialized otologic examination in 1704 to a versatile therapeutic instrument utilized across several medical disciplines. It is noteworthy that a procedure articulated over three centuries ago continues to be imparted to every medical student and is routinely utilized at the bedside and in the operating theater. This lasting significance underscores Valsalva's perceptive grasp of physiology. The move acts as a tangible link between early modern medicine and

contemporary practice a direct approach that has endured beyond several pharmaceuticals and instruments in the medical arsenal.

Historiographical Perspectives and Lasting Legacy

Historians have examined Antonio Maria Valsalva's influence on medicine, frequently juxtaposing it with that of his distinguished contemporaries. Valsalva was the quintessential Enlightenment physician: erudite in theory yet anchored in practical practice, inventive yet reverent of established knowledge, and scientifically inquisitive while maintaining compassion. Contemporary researchers attribute to him the facilitation of a novel epoch in experimental, observation-driven medicine within a historically conservative medical framework. Fughelli et al. (2019) characterize Valsalva as “a pivotal moment in the history of medicine,” emphasizing that *through* his “gentleness, diligence, and humanitarian ethos,” he persuaded established authorities to embrace novel scientific concepts. In contrast to several early innovators who encountered significant opposition, Valsalva's personal attributes, integrity, compassion, and collegiality, undoubtedly facilitated the acceptance of his changes, thereby leading to the depiction of his revolution as “smooth.”²

Comparisons are made between Valsalva and his contemporaries in other parts of Europe. For example, Marcello Malpighi utilized the microscope to identify capillaries and mostly engaged in pure study. Valsalva dedicated more time to dissection and clinical practice, merging research with education and application. In France, Jean-Louis Petit and Henri-François Le Dran were pioneering advancements in surgery and head injury treatment during the early 18th century; however, Valsalva in Italy had previously anticipated some of their concepts, including the distinction between concussion and compression in head trauma, which Le Dran articulated in the 1740s, while Valsalva had observed signs of increased intracranial pressure decades earlier. Regarding compassion in psychiatry, Valsalva predates Philippe Pinel who notably unshackled the mentally ill in Paris in 1795 by nearly a century, indicating that a desire for compassionate treatment existed earlier, albeit in sporadic circumstances.

Another aspect of Valsalva's legacy is the eponyms an enduring method of commemoration in medicine. Table 1 in the preceding section enumerates several words associated with his name. Such eponyms ensure that nearly every medical student is acquainted with Valsalva, regardless of their familiarity with his complete history. Nevertheless, several historians warn that eponyms may obfuscate the comprehensive nature of an individual's contributions. Valsalva's name associated with a technique or sinus may cause people to underestimate his extensive achievements. Consequently, subsequent pieces like “Popping Ears and Tingling Tongues” have sought to interpret Valsalva outside its eponymous association. He is shown as an early critical care physician (utilizing fluid analysis as a rudimentary diagnostic tool), an otologist, a cardiologist, and a psychiatrist simultaneously genuinely a medical polymath.^{5,14}

From a historiographical standpoint, Valsalva's life has been examined as a paradigm of the post-Renaissance transformation in medical epistemology. He practiced during an era when colleges such as Padua, Leiden, and Bologna were formalizing new medical curriculum that prioritized anatomy and empirical observation above academic debate. Valsalva's prominence in Bologna's medical community, culminating in his presidency of the Academy of Sciences, illustrates the institutionalization of innovative procedures within a conventional framework, as Bologna's medical school had origins in the medieval period.³¹ Scholars like Patrizia Fughelli have noted that Valsalva, via his personal charm and rigor, successfully reconciled traditional and modern practices: Galenic medicine remained in the curriculum, while he enriched it with empirical facts.² His thesis on experimental doctrine vs old theology serves as a definitive statement of that transformation. Historians frequently reference Valsalva's career as a representation of the Enlightenment's influence on medicine, a period during which rationality and experimentation began to overshadow reverence for ancient authorities such as Hippocrates and Galen.^{32,33}

Ultimately, Valsalva's influence endures through continuous study and citations in contemporary medical literature. In the 21st century, studies persist in being produced on subjects like as "Valsalva maneuver in echocardiography" and case reports of "Valsalva retinopathy," demonstrating that his name remains relevant in contemporary research. Castiglione (1932) emphasized Valsalva's role as a pivotal transitional figure in the history of anatomy, highlighting his contributions to empirical observation and anatomical methodology.

Meirelles (2008) focused primarily on Valsalva's foundational work in otology, underscoring the lasting importance of *De Aure Humana Tractatus* in the systematic study of the ear.

More recently, Yılar et al. (2023) provided a comprehensive clinical historical assessment of Valsalva's work, drawing attention to his contributions to otology and physiology and their relevance to modern medical practice. In summary¹², historiography treats Valsalva as a figure who may not have a single monumental discovery to rival Harvey's circulation or Vesalius's *Fabrica*, but whose collective body of work significantly advanced medical science and embodied the best of his era's values. His impact is obvious in both the methods and language of contemporary medicine, as well as in the compassionate philosophy that progressively infused medical treatment.

Valsalva's Legacy in the Ottoman Medical Tradition

Considering that a potential publication for this essay is a Turkish medical history magazine, it is appropriate to examine how Valsalva's contributions interacted with or impacted Ottoman medicine during the 18th and 19th centuries. Throughout Valsalva's lifetime (late 1600s to early 1700s), the Ottoman medical system remained mostly rooted in traditional Islamic and Greco-Roman medical doctrines. During that period, dissection was not a standard component of medical education in the Ottoman Empire, owing to religious and cultural conventions, and the advanced anatomical knowledge from Europe did not swiftly infiltrate Ottoman practices. Nonetheless, the early 18th century, known as the Tulip Era in the Ottoman Empire, witnessed a rise in diplomatic and scholastic interactions with Europe, paving the way for the ultimate incorporation of modern medical practices.^{20,24}

Direct evidence of Valsalva's impact in Ottoman medical literature emerges during the late Ottoman period. An intriguing instance is included in an 18th-century Ottoman surgical manuscript by Bursalı Ali Münşî, which delineates a method that efficiently employs the Valsalva maneuver. In the context of head injury therapy, Ali Münşî recommends that the patient occlude their nose and mouth and do a Valsalva maneuver to remove pus from beneath the dura mater within the skull. The manuscript clearly identifies this as the "Valsalva maneuver," suggesting that Ottoman surgeons of that period recognized Valsalva's method and terminology. This is significant as it demonstrates a transfer of knowledge: European surgical methods had permeated the Ottoman domain to the extent that an author composing in Ottoman Turkish could cite Valsalva by name. It also emphasizes the maneuver's apparent efficacy in neurosurgical circumstances such as subdural empyema.^{34,35}

Other indications of the progressive establishment of Western medical influence are evident. In the 19th century, the Ottoman Empire commenced significant improvements in medical education. The inaugural modern medical school, *Tıbhâne-i Âmire*, was established in 1827 and started instruction in medicine with a more European approach (originally in Turkish, supplemented by translations of European textbooks).³⁶ Anatomy, including dissection, was incorporated into the medical curriculum through translated compendiums and French-language medical textbooks, drawing on the works of Morgagni, Vesalius, and related anatomical traditions. During the nineteenth century, Ottoman medical literature increasingly referred to contemporary European medical advances.

Nineteenth-century Ottoman medical literature, including periodicals and compilations, began to reference contemporary European medical advancements. An Ottoman collection on surgery or internal medicine

from mid-nineteenth century Istanbul may cite procedures for treating hydrothorax or otological disorders, originating from figures such as Valsalva, but frequently without explicit credit.

Furthermore, Valsalva's humanistic approach to the treatment of the mentally ill aligned with certain Ottoman customs. Historically, Ottoman and Islamic medicine exhibited examples of compassionate care for the mentally ill; for example, Ottoman sultans established bimaristan institutions in the 15th century, where music and kind therapy were employed for psychiatric patients. Although Valsalva probably did not directly impact those traditions, it is an intriguing connection that both the Islamic world and Valsalva's ideology saw the mentally sick as individuals deserving of care rather than punishment. By the late 19th century, the Ottoman Empire instituted modern asylums, reflecting a broader movement towards more humane treatment in accordance with worldwide advancements.

In conclusion, Valsalva's contributions did not exert an immediate influence on Ottoman medicine during the eighteenth century. Their impact became more evident in the nineteenth century, as the Empire underwent processes of medical modernization and increasingly incorporated European medical knowledge. The reference to the Valsalva procedure in an Ottoman surgical textbook indicates that at the empire's conclusion, Turkish surgeons were cognizant of his accomplishments. This crosscultural exchange underscores the worldwide significance of Valsalva's inventions and the interdependence of medical advancement.

Conclusion

Antonio Maria Valsalva's life and contributions epitomize the transformational period of medicine in which he existed. He passed away in 1723, although the strands of his impact persist over the subsequent centuries. As an anatomist, he provided detailed descriptions of human anatomy, particularly of the ear. As a physiologist, he pioneered studies and concepts, the Valsalva maneuver, which elucidated essential principles of physiological function. As a surgeon, he advocated for creative and humane approaches, enhancing patient care and surgical results. As a teacher and humanist, he made a lasting impact on his mentees, advocating for a perspective of medicine that was both scientifically rigorous and profoundly humanistic.

The lasting influence of Valsalva is seen in the continual incorporation of his name into medical terminology and practice. The Valsalva maneuver is a straightforward yet effective bedside technique utilized daily by everyone, from airline travelers alleviating ear pressure to cardiologists managing arrhythmias. The sinuses of Valsalva continue to be taught in anatomy laboratories and are a factor in heart surgery. Contemporary therapeutic recommendations incorporate modified "Valsalva maneuvers" as the primary intervention for certain tachyarrhythmias. These examples demonstrate the enduring clinical relevance of a procedure first described in 1704. Furthermore, modern research persists in exploring topics introduced by Valsalva; for example, current otologic studies reference Valsalva about Eustachian tube function, while cardiologists examine the hemodynamic intricacies of the Valsalva maneuver to enhance diagnostic accuracy. Thus, Valsalva's contributions serve as a nexus between the early Enlightenment and contemporary advanced medicine.

Recognizing the historical relevance of Valsalva's methodology is also essential. He was an advocate of the scientific method in medicine, depending on data and observation during an era when this approach was unconventional. His position on the "experimental doctrine" attacked entrenched dogmas and facilitated the emergence of evidence-based medicine. Valsalva's achievement in assimilating these concepts into conventional practice, while maintaining collegial relations, exemplifies the efficacy of merging innovation

with communication and empathy. Openmindedness, meticulousness, and compassion are as vital for contemporary physicians as they were during Valsalva's era.

In conclusion, Antonio Maria Valsalva is not only an eponym or a historical figure, but also lasting embodiment of medical brilliance. His impact is multifarious: scientific contributions that enhanced knowledge, educational initiatives that cultivated future pioneers, and a paradigm of care that emphasized compassion and respect for patients. Valsalva's influence persists in contemporary medicine whenever a physician advises a patient to "Perform a Valsalva Maneuver" or an anatomist identifies the sinuses of Valsalva on a cardiac specimen. Valsalva's enduring achievements and elevated standards have established him a revered position in medical history, with his work continuing to inspire and educate medical practice over three hundred years posthumously.

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Author Contributions

Burak Kucuk: Idea/Concept, design, data collection, analyses and interpretation, literature review, writing-review, critical review.

Nilufer Demirsoy: Idea/Concept, design, data collection, analyses and interpretation, writing-review, critical review.

Hilmi Ozden: Idea/Concept, supervision, analyses and interpretation, critical review.

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