Review Article

Cardiovascular medicine in Morgagni’s *De sedibus*: dawn of cardiovascular pathology

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**A B S T R A C T**

The most significant cardiovascular anatomoclinical observations from Morgagni's masterpiece *De sedibus et causis morborum per anatomen indagatis* (1761) are herein reported, divided into the current taxonomy according to cardiac structure: (a) aorta and pulmonary artery, (b) pericardium, (c) coronary arteries, (d) myocardium, (e) endocardium, (f) congenital heart defects, and (g) heart rhythm disorders. Morgagni's interpretations in cardiovascular pathology were strictly related with the most advanced theories of his time, such as those of blood circulation and iatromechanics; nevertheless, he remained close to the empirical description of clinical and pathological anatomy phenomena with their individual specificity. Through a systematic review of the literature, he compared the data from his own observations and experiments with those from physicians he considered reliable by applying the method of literature review which is still valid nowadays.

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1. Introduction

The University of Padua, which was founded in 1222 and thus is one of the most ancient in the world, has been the center of scientific Renaissance, in particular thanks to seminal discoveries in cardiovascular medicine. Here, Andreas Vesalius (1514–1564) was professor of Anatomy and Surgery from 1538 to 1543 and, unlike Galen of Pergamum (129–216/217 AD), systematically carried out human dissections and challenged many of Galen's anatomical views, which represented a dogma of classic medical knowledge. With the *De humani corporis fabrica*, he founded research, teaching, and divulgation of modern human anatomy [1]. Vesalius' new anatomy would have brought not only a new morphological knowledge but also the prerequisite of a new physiology, which fully developed in the following XVII century.

The patency of the interventricular septum was one of Galen's fundamental beliefs, according to which the blood passed from the right to the left ventricle through invisible pores. Vesalius clearly denied these structures: "However much the pits may be apparent, yet none, as far as can be comprehended by sense, passes through the septum of the heart from the right ventricle into the left [...] As a result – as I shall declare more openly elsewhere – I am in no little doubt regarding the function of the heart in this part" [2]. If the blood could not pass from right to left ventricle through the interventricular septum, it was necessary to look for an alternative way; otherwise, that arteries were filled up by blood would have been inexplicable [3]. For Galen, blood and natural spirit were produced by the liver and reached the right side of the heart through the vena cava. The blood with vital spirit was produced in the left ventricle by air coming through pulmonary veins mixed with blood and natural spirit, coming from right ventricle through pores of the interventricular septum.

It is not by chance that pulmonary circulation was later discovered by Matteo Realdo Colombo (1516–1559), one of Vesalius' students, and described in his *De re anatomica* [4]. Colombo was the successor of Vesalius at the chair of Anatomy and Surgery in Padua. Doubts and suggestions of his master pushed Colombo to find a solution. In his *De re anatomica*, pulmonary circulation was clearly discovered through vivisection by opening the pulmonary veins in living dogs: "I believe [...] the function of the pulmonary vein is to lead blood mixed with air from the lungs to the left ventricle of the heart [...]. If you observe cadavers as well as living animals, you will always find the pulmonary vein full of blood, which is not possible if this vein was to carry only air and fumes" [4]. The discovery of pulmonary circulation, in turn, was the starting point to investigate systemic circulation, and again, this discovery was conceived in Padua, thanks to William Harvey (1578–1657), who was there a student and graduated in 1602. In his *Exercitatio anatomica de motu cordis et sanguinis in animalibus*, Harvey explicitly declared his debt to Padua Medical School [5]. One of Harvey's starting point, in fact, was the discovery of venous valves by Girolamo Fabrici d'Aquapendente (1537–1619), who was a pioneer in embryology, anatomy, and surgery. In his description of the valves observed in large veins, Fabrici misunderstood their function, explaining them as structures for slowing down and deviating the centrifugal blood stream to the tissues of the body, where it was consumed [6]. On the opposite,
Harvey, who was a student in Padua exactly in the period when Fabrici was describing these structures, understood that venous valves had an antireflux function with a centripetal rather than centrifugal flow of the venous blood.

Harvey’s discovery represented the dawn of modern medicine because it obliged physicians to rewrite human physiology after a millennium of sharing the Galenic model. Of note, Harvey estimated that the volume of blood passing through the heart in half an hour was nearly 12 kg and surmised that the liver was unable to produce such amount of blood in a short period. This plenty of blood could be explained only by a circuit. Thanks to this physiomathematical model, he paved the way to XVII and XVIII centuries iatromechanism, a system according to which the body was a hydraulic machine in which humors flowed in corpuscular agitation.

Marcello Malpighi (1628–1694), professor of medicine in Bologna, Pisa, and Messina and archiater of Pope Innocent XII (1615–1700), was one of the most important iatromechanists in Italy and Europe, developing a method followed by generations of scholars. According to Malpighi, the body was a “glandular machine,” where the corpuscles of blood, pushed to circulate in a hydraulic system by a pump (the heart), were sieved by different filters (the glands), thus producing the humors necessary to the functions of the organism.

Giovanni Battista Morgagni (1682–1771), born in Forlì, studied medicine in Bologna, where, from 1698 to 1709, he became friend and assistant of Antonio Maria Valsalva (1666–1722), a pupil of Malpighi. Valsalva taught to the young Morgagni the characteristics and the method of Malpighi’s iatromechanical approach. Morgagni was forced to leave Bologna in 1709 for his belonging to Malpighi’s school, and a couple of years later, after a period in Venice, he was called to the chair of Theoretical Medicine at Padua University on October 1711. He then moved to the chair of Anatomy from 1715 until his death in 1771. During this long period, Morgagni founded the pathology lasting school of the XVIII century by combining Malpighi’s heritage and the extraordinary Padua’s tradition in anatomy and physiology of the previous centuries. In 1761, he published De sedibus et causis morborum per anatomen indagatis, by which he systematically developed the method of anatomoclinical correlations [Fig. 1] [8,9]. In about 700 cases, divided in 70 anatomoclinical letters, each one for a disease or a syndrome, and 5 books, each for a body part, from head to toe, he correlated clinical signs and symptoms observed in living patients with morphological substrates found at autopsy [10]. Many of the cases described in De sedibus came from Morgagni’s personal clinical and pathological experience since he could make the autopsy of the patients he cured by himself. He explained symptoms as caused by lesions in the organs, which were considered to account for diseases (dawn of organ pathology). This was revolutionary because, according to the classic humoral pathology, diseases were caused by an unbalance among the four humors of the body: blood, black bile, yellow bile, and phlegm. On the opposite, Morgagni considered an organic lesion as the damage of a structure in the body-machine that caused a functional disorder, thus giving origin also to physiopathology.

Although Morgagni followed Malpighi’s new method, he never completely rejected ancient knowledge and experiments. Empirical approach was also developed with attention to description of clinical phenomena and to avoid the elaboration of hypotheses without direct support of observations.

2. Cardiovascular medicine in Morgagni’s works

In his academic lectures on Theoretical Medicine (1711–1715), published posthumously, Morgagni taught to his students how to understand the anatomy and physiology of the cardiovascular system according to a mechanistic model [11]. For instance, in 1714, by explaining the pulse theory of Galen, Morgagni was able to convert classical concepts into the modern iatromechanical ones. First of all, the phenomenon of “pulse” corresponded to the artery diastole due to the blood ejected by the heart. After the left ventricle’s systole, the blood was pushed into the arteries, which were dilated by its passage. Blood being a fluid that cannot be compressed, the impulse from the heart
was transmitted immediately along all the arteries. The causes of pulse were thus three, i.e., the cardiac contraction, the blood pushing within arterial lumen, and the arteries’ dilatation. The physiological and pathological phenomena of pulse, by consequence, could depend from these factors, which deserved to be considered separately.

Classic Galen physiology, instead, was based on the four qualities of hot, cold, dry, and wet. Therefore, a hard pulse meant a dry heart, while a soft one meant a humid heart. Morgagni translated these concepts with modern ones related to the chemical composition of blood. Indeed, a hard pulse indicated a blood poor of serum, while a soft one indicated a blood rich of serum.

Finally, he refuted the Galenic theory of hepatic blood production, also by conducting experimental observations. In the fecundated chicken egg, for instance, it was possible to see blood vessels departing from pulsating ventricles after 48 h from the fecundation, while the liver was produced from the chyle directly inside blood vessels. When the particles of chyle penetrated in the blood stream, they were mixed with the particles of air and cleared from the slags through the pressure and the movement of the cardiovascular system, thus becoming new blood.

During his life, Morgagni was called “Prince of the European anatomists” because he made seminal discoveries in the discipline [13]. His achievements are remembered with many eponyms, such as Morgagni’s ventricles (lateral pouches in the vestibulum laryngis between the ligamentum vestibulare and the vocal cord), Morgagni’s anal columns (vertical folds of the rectum), and Morgagni’s caruncle (portion of the prostate lying between the urethra and the ejaculatory ducts). In this regard, Morgagni described the finest structures of the body because he followed Malpighi’s example, who was the founder of “subtle anatomy.” These structures were conceived as the key components of the organic machines, fundamental to understanding their function. If Malpighi used mainly the microscope for achieving his famous discoveries, such as blood capillaries and renal glomeruli, Morgagni preferred to avoid this instrument because he was afraid of the potential visual distortion of an instrument not yet sufficiently reliable [14].

Thanks to the subtle anatomy approach, Morgagni made important discoveries also in cardiovascular anatomy, completing the description of the aortic valve nodules, originally made by the Italian anatomist Giulio Cesare Aranzi (1529–1589) [Fig. 2] [15], and of the aortic sinuses, described by his master Antonio Maria Valsalva (Fig. 3) [16]. Aortic valve nodules are small fibrous protuberances at the center of each cusp and contribute to the hermetic closure of the aortic valve. Aortic sinuses are three anatomic dilations of the proximal ascending aorta, just above the aortic valve. The left aortic sinus gives rise to the left coronary artery and the right aortic sinus to the right coronary artery, whereas the posterior aortic sinus usually does not give rise to any vessel and therefore is known as the noncoronary sinus. Valsalva and Morgagni understood the hemodynamic function of the sinuses, which are necessary to create a vortex for aortic valve closure. Of note, Leonardo da Vinci (1452–1519) perceived this function well before Valsalva and Morgagni but did not publish his observations [17].

3. Cardiovascular pathology in Morgagni’s De sedibus

Within De sedibus, Morgagni addressed cardiovascular pathology in Book II, about the “Diseases of the chest” with the anatomomedical letters XVII and XVIII “On Respiration being Injured from Aneurysm of the Heart, or Aorta, within the Thorax”; XXIV “On Preternatural Pulses”; XXVI “On the Sudden Death, particularly from a Disorder of the Blood-Vessels in the Thorax”; and XXVII “On the Sudden Death from a Disorder of the Heart”. Other diseases are considered in Book V “On supplemental cases.”

More in detail, they can be anatomically reorganized according to the following categories: (a) aorta and pulmonary artery, (b) pericardium, (c) coronary arteries, (d) myocardium, (e) endocardium, (f) congenital heart defects, and (g) heart rhythm disorders. As we will see, it is possible to follow such taxonomy because the cases described by Morgagni were so detailed and clearly exposed that they can be arranged into the current system.

We will report only the most significant cases for each category by underlying that Morgagni revisited the whole cardiovascular pathology of his time with his new anatomoclinical method. One of the fundamental features of his method, in fact, was the attempt to give a sort of statistical basis for each nosographic category by analyzing the widest number of corresponding individual cases. By this approach, he aimed to present the most common and rare clinical and anatomical features of any disease investigated in De sedibus. To every Morgagni’s case here-in reported, we have associated a gross picture taken from our collection. Our aim is to give to the reader a visual perception of what Morgagni was describing at the anatomical table.
3. Aorta

3.1. Syphilitic aneurysm

In the anatomomedical letter XXVI, Morgagni reported the clinical history of a “man [who] was affected by pain at both arms and fever. Soon after, a tumor similar to a big pimple manifested at the superior part of the sternum. [...] When the patient was admitted to the Hospital for Incurables, this tumor was starting to ooze blood. [...] The death occurred for an enormous shedding of blood [...].”

At autopsy, “in the chest a big aneurysm was discovered. It was formed by an expansion of the anterior wall of aortic arch and partially destroying the sternum and the extremity of clavicle placed on this bone, as well as the nearby ribs.”

This was the consequence of a syphilitic aneurysm of the aortic arch, quite common at that time (Fig. 4) [18]. The man, in fact, was admitted to the Hospital for Incurables, established during the XVI century specifically for syphilitic patients.

Morgagni explained the pathogenesis of the syphilitic aneurysm by an iatromechanical model: “[…] I have no doubt that corroding particles in the humors of those who are infected by syphilis stick on the membranes of the arteries. They corrode them and predispose arteries to dilatation […]” (anatomomedical letter XXVII). Morgagni did not try to

Fig. 4. A case of a syphilitic aneurysm quite similar to that described by Morgagni in a man in the anatomomedical letter XXIV. Note on the left the penetrated sternum and on the right the huge aneurysm of the aortic arch (University of Padua, Museum of Pathological Anatomy) [17].

Fig. 5. Close-up of Diego Rivera’s fresco on the history of cardiology at the National Institute of Cardiology Mexico City. Morgagni, at the top-center, is indicating with his left hand the site of a chest aneurysm in a dying patient and with the right one the heart of the same patient at autopsy with a huge aorta. Morgagni is standing between William Harvey, on his right, and Marcello Malpighi, on his left, which could mean that he applied their teaching on pathology. Andreas Vesalius, on bottom right, is dissecting a heart with a normal aortic arc [18].
explain the origin of these particles because he was rather interested to propose a mechanical process to explain the rupture of the aortic arch. According to Morgagni, these “corroding particles” accounted for the rough and pitted intima shape, which now is called “tree-bark appearance” due to the inflammatory involvement of the aorta (“mesoartitis”) and obliterative endarteritis of the vasa vasorum. This leads to narrowing of the lumen of the vasa vasorum, producing ischemic injury of the aortic media, which causes the typical retraction of the intima, as well as loss of elastic support and dilation of the aorta.

Interestingly, the case reported by Morgagni is depicted in the frescos on History of Cardiology by Diego Rivera (1886–1957) at the Mexico City National Institute of Cardiology (Fig. 5) [19]. In Rivera’s frescos, Morgagni is indicating with his left hand the site of an aneurysm in the chest of a dying patient and with the right one is opening the huge aorta from the dead body of the same patient, quite simple and immediate representation of the anatomoclinical method [10]. Moreover, Morgagni is standing between William Harvey and Marcello Malpighi, which could mean that he applied their teachings to pathology. He interpreted Harvey’s theory of blood circulation, in fact, with the iatromechanical concepts of Malpighi. In his autobiography, Morgagni declared that in Padua, he was “[…] the first to teach the discovery of blood circulation, drawing conclusions completely different from the ancient theories that remained in vague at Padua University because of the laziness of their professors” [20].

In the anatomomedical letter XXVI, Morgagni reported another case of syphilitic aneurysm with vivid and rough words: “An 18-year-old prostitute […] since some time was complaining about a certain fatigue and dislike to food […]. Her neighbors, seeing a man confused and agitated escaping from her house and noting her absence in the following two or three hours, entered in the house and found her not only dead, but also cold, reclined on the bed, in a position clearly indicating when and how she died, given that some sperm still flowed from her genitals.”

At autopsy, Morgagni found “[…] an internal lesion that originated from the left extremity of the aortic arch, extending to the heart and becoming as bigger as closer to the heart. […] Close to the semilunar valve, a lesion of the aorta communicated internally with a roundish aneurysm, hanged to the artery like a sack. […] it was broken in its upper part, from where the blood penetrated into the pericardial cavity”.

3.1.2. Dissecting aneurysm

In the same anatomomedical letter XXVI, Morgagni reported a case of a “fat woman, 50-year-old, sober, textile worker, [who] since some year complained bursts of heat around the heart.” She died suddenly while preparing a new canvas.

At autopsy, Morgagni found that “in the aorta the blood opened a way under the external tunica. Firstly, it detached the external from
the internal one and then it ruptured the external, pouring into the pericardial cavity.”

To the best of our knowledge, this is the first anatomoclinical account of aortic dissection (Fig. 6). Morgagni clearly indicated the mechanism of the disease, characterized by the blood penetrating the aortic wall and creating a second lumen. The force of the blood entering the media caused the splitting to extend, creating a false lumen that could break into the pericardial cavity (hemopericardium), causing the death by cardiac tamponade.

### 3.1.3. Coarctation of subdiaphragmatic aorta

Again in the anatomomedical letter XXVI, Morgagni reported the case of a “[…] 30-year-old shoemaker, [who] since few years was affected by breathing difficulty […]”, and was troubled also by feeling of faintness and dizziness […]]: finally, after going upstairs in the hospital, he complained pain around the region of diaphragm. […] he vomited green matter and died half an hour after his arrival at the hospital.”

At autopsy, “[…] the things which drew more attention was the smallness of the aorta that, starting from the diaphragm until its bifurcation, could better belong to a little woman than a man like this one, who was quite tall. […] the heart was bigger than two normal hearts taken together. Both the atria were bigger than normal, but especially the ventricles and in particular the left one, were much bigger than normal. […] Even if the aorta did not appear dilated […], it showed remarkable lesions on the internal side all along its trunk, as much as closer to the heart. The aorta, apart the iliac arteries, was internally covered by whitish spots, beginning of future ossifications, as much as closer to the chest, to such an extent that just before the left subclavian artery, these spots were almost as osseous squama.”

Morgagni attributed the dilatation of the heart to the small dimension of the aorta because it obliged the heart to pump blood with violence. The high pressure, in turn, damaged the aortic walls, causing the ossifications.

Morgagni was describing a case of coarctation of the subdiaphragmatic aorta. The presence of atheromatous plaque is commonly observed in patients older than 20 years, exactly as in Morgagni's anatomoclinical report.

### 3.2. Pulmonary artery

#### 3.2.1. Pulmonary thromboembolism

In the same anatomomedical letter XXVI, Morgagni reported a case of pulmonary embolism: “An old man [who] was admitted to the hospital with a broken leg. Soon after, physicians found he was without pulse and then he died.”

At autopsy, “the heart and the major vessels were full of clots, among them there was one whitish and solid. The latter clot could explain asphyxia.”

Morgagni understood that the cause of death was a thromboembolism of the pulmonary artery leading to asphyxia (Fig. 7). Clearly, it originated from a thrombus of the veins of the fractured leg of the patient.

### 3.3. Pericardium

#### 3.3.1. Constrictive pericarditis

In the anatomomedical letter XXIV, Morgagni analyzed the case of a “40-year-old man with weak pulses [who] developed under skin a tumor at one side of the head which degenerated in abscess and died.”

At autopsy, Morgagni described the “lungs strictly adhering to the pleura and the heart to the pericardium, the latter accounting for diastolic impairment.”

Interestingly, Morgagni correlated the condition of the pericardium with the “weak pulse” featuring the clinical state of the patient. The thickened fibrotic pericardium, in fact, hindered normal diastolic filling. We can easily interpret the patient as affected by scrofula and constrictive tuberculous pericarditis (Fig. 8).

### 3.4. Coronary arteries

#### 3.4.1. Coronary atherosclerosis and myocardial ischemia

In the same anatomomedical letter XXIV, Morgagni told of an “old man, admitted to the hospital for an enterocele, [who] died suddenly.”

The autopsy report was the following: “Analyzing the external face of the heart I saw the coronary artery transformed into an osseous conduit from its origin up to the base of the heart. Moreover, a portion of one of its longer branches, which extend along the anterior face of the heart, was ossified for the length of three fingers.”

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**Fig. 8.** A case of constrictive pericarditis mimicking the one described by Morgagni in a 40-year-old man in the anatomomedical letter XXIV (University of Padua, Cardiovascular Pathology archive).

**Fig. 9.** A case of calcific coronary atherosclerosis similar to that reported by Morgagni in an old man in the anatomomedical letter XXIV (University of Padua, Cardiovascular Pathology archive).
Morgagni was describing a calcific atherosclerosis of the left anterior descending coronary artery (Fig. 9). “Ossification” was the usual term employed to designate the condition. The first who described the phenomenon of atherosclerosis, with also a precise illustration of the aorta, was a contemporary of Morgagni, the Swiss anatomist Johann Jacob Wepfer (1620–1695) who was properly quoted in De sedibus [21].

3.4.2. Postinfarction cardiac rupture and tamponade, dystrophic calcification of the mitral annulus
In the anatomomedical letter XXVII, Morgagni analyzed the case of a “woman, 75-year-old, with virile appearance, very fat, [who] after a vertigo died suddenly.”

At autopsy, he found that the “pericardium was spherical because full of blood. The posterior face of the heart had a laceration. By opening longitudinally the left ventricle, I saw a round hole penetrating the wall of the ventricle, from which blood came out from the heart. I saw an ossified half ring to which the mitral valve leaflets were attached. They were also ossified, apart from one of them which was almost completely normal and allowed the closure of the orifice that became restricted because of the ossifications protruding internally. Also the aortic valve cusps were starting to ossify.”

It was a case of postinfarction free wall rupture with cardiac tamponade (Fig. 10) and dystrophic calcification of the mitral annulus (Fig. 11). This is one of the first cardiac ruptures documented in the medical literature.

3.5. Myocardium
3.5.1. Cor pulmonale
In the anatomoclinical letter XXII, Morgagni described a “man who sifted wheat […] affected by recurrent pleurisy and angina.” He had a recurrence of pleurisy with angina, in particular in the right part of the chest, and died at the 11th day of disease.

At autopsy, he found that the pleural cavities were full of water to such an extent that Morgagni spoke about a chest dropsy. Moreover,
the heart at autopsy was enlarged, in particular the cavities of the ventricles.

He gave the following physiopathologic interpretation of the enlargement of the heart: “If blood find closed passage to the lungs because of their inflammation, it will stagnate in the right cardiac cavities, causing their dilatation, because lungs are an obstacle to drain the blood.” He said that he had observed many other cases of right ventricle dilatation due by pleurisy and pulmonary inflammation. The condition of the heart was due not only to the last pleurisy, which caused the death, but also to the several other morbid phenomena which affected the patient in the past.

Therefore, Morgagni was describing a cor pulmonale, clearly understanding why this condition caused the right ventricle dilatation. He was the first to understand the physiopathological relationship between the lungs and the right ventricle.

3.6. Endocardium

3.6.1. Aortic valve incompetence and cor bovinum

In the anatomoclinical letter XXVII, Morgagni described a “young with good constitution, but affected by breath difficulties since long-time, [who] died suddenly during a trip done on foot and on horseback.”

At autopsy, he found that “the heart was bigger than an ox heart, due to the enlargement of its cavities, rather than by the thickness of its walls, in particular the left ventricle. Semilunar valves were hard, wrinkled and retracted.”

It was a case of cor bovinum due to rheumatic valve disease with aortic incompetence (Fig. 12). Note that Morgagni specified that the enlargement of the heart was explained by the cavities being larger than normal (eccentric hypertrophy).

3.6.2. Infective endocarditis of the aortic valve

In the anatomoclinical letter XXIV, Morgagni reported the story of a “man, 36-year-old, affected by a disease with dropsy of the chest. He had swollen legs, very slow pulse, and was also affected by gonorrhea, so he died.”

The autopsy report was the following: “Aortic valves were swollen because of excrescences leaving very little space for the passage of blood. Right cusp was shorter than left one, which was ulcerated and presented another vegetation, both fragile and hard.”

Morgagni was describing a case of subacute ulcerovegetative aortic valve endocarditis (Fig. 13), which was probably a complication of the gonorrhea. Of course, he could not realize yet that it was a bacterial infective disease.

3.7. Congenital heart defects

3.7.1. Pulmonary valve stenosis with atrial septal defect

In the anatomomedical letter XVII, Morgagni reported the clinical history of a “girl, who was sick since birth and died at the age of 16.” At autopsy, Morgagni found that “the heart was small […] the right ventricle had the shape of the left one […] the foramen ovale was patent […] the sigmoid pulmonary valves were cartilagineous with a small orifice.”

He gave the following interpretation of the patient clinical condition: “I believe that the lesion was present at birth […] and that the livid skin was due to blood stagnation and to the existence of foramen ovale, the valve of which was pushed from right to left [...].”

Thus, for the first time in medical literature, Morgagni was describing a case of pulmonary valve stenosis with atrial septal defect.

Fig. 12. A case of rheumatic aortic valve incompetence with cor bovinum quite similar to that reported by Morgagni in a young man in the anatomomedical letter XXVII (University of Padua, Cardiovascular Pathology archive).

Fig. 13. A case of ulcerovegetative endocarditis of the aortic valve mimicking the one described by Morgagni in a 36-year-old man in the anatomomedical letter XXIV (University of Padua, Cardiovascular Pathology archive).

Fig. 14. Drawing of pulmonary stenosis with atrial septal defect well depicting the case of a 16-year-old girl reported by Morgagni in the anatomomedical letter XVII. Note the right-to-left shunt at the level of patent foramen ovale.
(Fig. 14). He surmised that the defect was present at birth and that the cyanosis of the girl was due to right to left shunt at the level of patent foramen ovale.

3.8. Heart rhythm disorder

3.8.1. Atrioventricular block

In the anatomomedical letter LXIV, Morgagni reported one of the most famous cases of De sedibus: “A 74-year-old merchant from Padua collapsed following a vertigo. Next days, he suffered from frequent epileptic attacks. Pulse was vigorous, but hard and rare, about two third less than normal. Death occurred after three or four attacks.”

At autopsy, Morgagni observed that “the heart was dilated because of ventricles cavities’ enlargement. The aorta was dilated in the same

Clinical characteristics of slow pulse and sudden loss of consciousness are typical of a condition due to an interruption of the electrical conduction between atria and ventricles, namely, atrioventricular (AV) block. Morgagni mentioned a previous description of slow pulse made by Marcus Gerbezius (1658–1718), a Slovenian physician who studied in Padua and had published a detailed observation of AV block already in 1717 in the book Pulsum mira inconstanta. He described a man with epileptic attacks in whom the basal pulse was slow (one out of three normal), “inequalis, inconstans & inordinatus,” emphasizing the peculiar pulse rarity and hardness. Despite this unequivocal historical background, the clinical entity of AV block is known with the eponym “Adams–Stokes syndrome” after the names of the two Irish clinicians Robert Adams (1791–1875) and William Stokes (1804–1878) who clinically reported in 1848 a series of such patients.

Some authors, however, introduced the eponyms of “Morgagni–Adams–Stokes syndrome”, “Gerbec–Morgagni–Adams–Stokes syndrome,” or even “Morgagni permanent bradycardia” because of the original Morgagni clinicopathological report.

Morgagni, by considering the heart such as the skeletal muscle driven by nerves, advanced that the disease was caused by a “disorder of the nerves directed to the heart and great arteries.” Even if William Harvey already advanced that the impulse of the heart spontaneously initiated from the right atrium, Morgagni’s idea was the most popular at that time. The complete identification of the cardiac conduction system was accomplished between the end of the XIX and the beginning of the XX century with the discoveries by Wilhem His (1831–1904) [22] and Sunao Tawara (1873–1952) [23] of the atrioventricular node and bundle, and the sinus node by Arthur Keith (1866–1955) and Martin Flack (1882–1931) [24].

4. Conclusion

At Morgagni’s time, medicine was divided among factions in strong opposition: a first supporting iatromechanics, a second continuing to maintain the tradition of ancient medicine, and a third discrediting iatromechanical approach in favor of a medical empiricism, focusing more on clinical features rather than on scientific theories. Morgagni was able to conciliate his iatromechanics with the other theories.

As seen above, Morgagni’s descriptions were so precise and accurate that, in many cases, we can easily recognize the pathologic conditions. Although he was following Malpighi’s iatromechanical approach that implied a strong conceptual framework according to which organisms were conceived as machines, Morgagni maintained a genuine look to the empirical phenomena on both the clinical and the pathological anatomy side. The combination between meticulous observations and cautious theorizations brought him to put forward conclusions which are acceptable even today, although of course his etiological interpretations were frequently different from the current ones.

By presenting some of the most interesting cases of De sedibus related to cardiovascular pathology, we omitted another typical characteristic of Morgagni’s method, namely, the rigorous method of reviewing the literature. Each group of cases for any disease, in fact, was preceded by an almost complete revision of the relevant ancient and modern literature. From this overview, Morgagni tried to find all the useful information for reconstructing a comprehensive picture of the clinical and anatomical features, both common and rare, as well as for understanding their causes and physiopathology. Morgagni was developing a sort of systematic review method of the literature, particularly useful when the results of single studies are scarcely significant. After the systematic review, Morgagni compared the data from literature with his own observations and experiments and with those from physicians he considered reliable, such as his master Valsalva and Théophile Bonet (1620–1689), whose Sepulcrethus (1679) pushed Morgagni in advancing anatomoclinical method [25]. In this way, he was able to clarify many concealed aspects of the clinical and anatomical features of several morbid entities, contributing to the development of diagnosis with therapy implications. Interestingly, Morgagni did not refuse the classic literature. Even if he followed the new doctrines of blood circulation and of body as a glandular machine, by denying classic theories of centrifugal blood distribution through the veins and body qualities of hot–cold–dry–wet, he was able to maintain everything else from the past that could be useful for clarifying the phenomena he studied. In this way, he was a supporter of the “modern” without being an opponent to the “ancient.” Clinical observations of the ancients represented a source of experience which deserved to be always kept into consideration. In his inaugural lecture at the University of Padua, in fact, Morgagni said, “There is no better time than the present one, because we can dispose of the experience of the ancient and the knowledge of the modern” [26]. Morgagni did not feel authorized to draw conclusions about any kind of pathology. Most of the discussions developed in De sedibus ended without a clear-cut conclusion, contrary to the typical method of other iatromechanists of his time. Following the empirical approach, Morgagni was very cautious about any kind of theory. For instance, in relation to the phenomenon of artery “ossification,” namely, atherosclerosis, Morgagni, first of all, suspended his judgment “until the truth will be revealed to my eyes thanks to new researches” [8]. This suspension had a precise epistemological justification: “phenomena are variables according to the different individuals” [8].

Following Malpighi’s iatromechanics, he built medicine on a solid theoretical base related to the new quantitative approach introduced in medicine. However, combining this approach with empiricism, he avoided the risk of unbalancing medical practice with an excess of theorization, as advanced by some iatromechanists of his time. By his empirical attitude, Morgagni paid particular attention to the realistic description of the features of single cases without trying to postulate rigid speculative models to level out individual specific characteristics.

Morgagni’s revolution was not yet a dramatic rupture with the past but an admirable synthesis, by which he was able to pick the best from the different schools of thought of his time. Cardiovascular pathology perfectly exemplifies this extraordinary method, which changed not only the way to look at diseases but also diagnostic with therapeutic implications. This is a lesson that could be useful even today, with the following assumptions: (a) base the research in a sound knowledge of the “state of the art” of the topic by a systematic review of the literature; (b) develop the research with a solid theory, but without being too confident in a theory, and with a careful observation of any detail of the phenomena; and (c) be cautious in the conclusion drawn from the research, always maintaining an open mind.

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