William Harvey (1578-1657): Discoverer of Blood Circulation

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William Harvey was the leading figure in cardiology during the 17th century. Although he had precursors, it is to him that we owe the discovery of blood circulation. It is known that Harvey, as “Lumleian lecturer”, had developed the concept of blood circulation in his lectures since 1615.1 In 1628, in his brilliant book Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus (An Anatomical Exercise on the Motion of the Heart and Blood in Living Beings), Harvey announced his discovery and, just as shocking, reported that the heart was a pump that pushed the blood around and around in the body. In the years that followed, Harvey’s circulation theory was greeted with great controversy among his colleagues, but in the end his ideas prevailed.

Life and career

Harvey was born in Folkestone in the county of Kent, England. He was educated at the King’s School, Canterbury, and Caius College, Cambridge. After a serious illness, he went to Padua in 1600, studying under Fabricio d’Acquapendente (1539-1619), whose views concerning the valves of the veins influenced Harvey’s research. In 1602, having graduated as a Doctor of Medicine, Harvey returned to England (Figure 1). In 1604 he married Elizabeth Browne. In 1615, he became Lumleian lecturer. By 1618 he had been elected a Fellow of the College of Physicians; he was appointed physician to St Bartholomew’s Hospital, London and later Physician Extraordinary to King James I. Though he was physician and friend to King Charles I throughout his tragic reign, Harvey was not knighted.

In 1649, his health status deteriorated and he suffered from multiple attacks of gout. Nevertheless, he continued his research and published in 1651 De generatione animalium, ending his scientific life in embryology as he had begun. On 3 June 1657, at age 79, William Harvey suddenly lost his vision, then his speech, as he succumbed to a massive stroke at home. His last act was to personally pass on his ring, watch and other mementos to his nieces and nephews. He was buried in the family vault at Hempstead, Essex.2

The blood circulation before Harvey

It is surprising to note that the exact mechanism of the blood circulation was ignored for a long time, despite the ideas of some innovators. Medical teachers were enslaved to the dogmatism of Galen’s (129-201) tradition and theories, which led to erroneous conceptions. The publication of Harvey’s theory formalised his discovery, brought closure to a long series of ana-
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The famous treatise of Harvey

In his monumental work de Motu Cordis, Harvey “demonstrated that all written till that moment on the movement and the function of the heart and arteries is not solid enough.” It was a great opportunity for him to refute Erasistratus and Galen and to greet Colombo and Fabricio d’Acquapendente. His treatise innovates by its conciseness, its clarity, the absence of ambiguous theories and the method of experimentation (Figure 2).

Chapter I of de Motu Cordis is largely a refutation of a number of ancient and traditional opinions concerning the heart, pulse and arteries. Harvey underlines the contradictions and the incoherence in the texts of Galen questioning “how blood, air and sooty vapours could be in pulmonary veins while their dissection reveals only blood?”

In the 2nd chapter, entitled The movement of the heart after the vivisection, Harvey refutes the old doctrine that the diastole or expansion of the heart was the essential cause of the motion of the blood. Harvey...
and there is also in the interventricular wall, an oval window which provides free communication between the two cavities."

Harvey visualises circulation “as a cyclic process of blood regeneration” in which “blood that went out from the heart to the tissues in a hot and vaporous condition returns to it cooled down and condensed.” At the commencement of the passage in chapter 8 he suggests a purpose for the circulation of the blood by drawing an analogy with the Aristotelian description of circular movements of air and rain and those of the “superior bodies” of the cosmos.

This metaphor of the movements allowed Harvey in a few paragraphs to indicate his notions regarding the physiological significance of the blood for the life of the whole organism, as he writes: “The heart, consequently, is the beginning of life; the sun of the microcosm, even as the sun in his turn might well be designated the heart of the world; for it is the heart by whose virtue and pulse the blood is moved, perfected, and made nutrient, and is preserved from corruption and coagulation; it is the household divinity which, discharging its function, nourishes, cherishes, quickens the whole body ....”

In chapter 9 of de Motu Cordis Harvey repeatedly appeals to calculation concerning the quantity of blood coursing through the heart, arteries and veins. His calculation of the daily quantity of the blood ejected by the heart was afterwards seen as the core of the discovery, even as the beginning of quantitative biology and medicine.

In the 10th to 13th chapters, Harvey provides a firm and independent confirmation of venous return and blood circulation. He presented an ocular experiment done with ligatures, which demonstrated the blood’s single directional path, showing how blood entered the arm by way of the arteries and exited via the veins. He observed the procedure on “country people or those who were ‘swollen veined’” in order to see the veins more clearly. The experiment showed the swelling of veins in the arm when a ligature is used to block blood flow back to the heart. Pressing between the swollen nodes, or valves, of the veins causes the blood flow to stop and the vein to flatten. After releasing the upper valve (the one closer to the heart), the vein does not refill until the lower valve is released. In chapters 15-17 he presents the new proofs of the theory of circulation from a pathological and therapeutic point of view, expressed and summarised in chapter 14. Furthermore, Harvey’s treatise goes beyond the theory of circulation, as it contains two notions that are fundamental to modern cardiol-
ogy: that of cardiac output and that of the pressures of the different sectors of the system.\(^5\)

**Harvey becomes a cardiologist: the description of atheroma and arteritis**

In his treatise Harvey does not refer to cardiovascular pathology. However in his second letter to Riolan, he becomes a true cardiologist as he writes: “The patient had reached about the middle period of life, made frequent complaint of a certain distressing pain in the chest, especially in the night season; so that dreading at one time syncope, at another suffocation in his attacks he led an unquiet and anxious life ... he became cachectic and dropsical and finally, grievously distressed he died in one of his paroxysms. In the cadaver, we found the wall of the left ventricle of the heart distended having a rent in it of size sufficient to admit any of my fingers.” Actually, Harvey had been the first to observe a rupture of the ventricular wall after myocardial infarction.\(^11\)

In addition, he observed a case of aortic atheroma: “I beg here to refer to a portion of the descending aorta of a nobleman and which is converted into a bony tube; by this hollow tube, nevertheless, did the arterial blood reach the lower extremities of this nobleman during his life and cause the arteries in these to beat.”\(^6\)

**Discussion**

Harvey was notable for collecting the prevailing ideas of his time and constructing his own schema of blood circulation. He presented his ideas in the *Lumleian lectures* in 1616.

His greatest work was his *De Muto Cordis* (1628). In this, and in two supplementary letters written twenty years later, he described his experimental analysis of the movements of the heart and blood, establishing that in systole the heart actively contracts in all dimensions, expelling its contained blood as a muscular pump. Cardiac diastole or dilatation he found to be passive, not active as Galen had held. By dividing arteries he showed that each systole of the heart pumped out blood in jets, the expansion of the arteries being felt as pulses in the limbs. Having demonstrated that the right ventricle is responsible for the pulmonary circulation, Harvey showed that the left ventricle supplied the rest of the body through its arteries. That blood flows towards the heart in the veins he demonstrated experimentally by cutting them, by obstructing them with ligatures, and by observing the action of their valves in preventing blood from moving to the periphery. Here again he contradicted Galen.\(^11\) Harvey estimated that the quantity of blood expelled from the heart was far greater than that ingested as food in the same time; he concluded: “Therefore the blood must circulate.”

Thus Harvey founded the systematic quantitative, experimental approach to physiology. Although at first violently opposed, Harvey’s work on the heart found general acceptance in his lifetime.

**References**