Da Vinci's code for surgeons

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There are three classes of people. Those who see; those who see when they are shown; those who do not see.


Sigmund Freud famously said of Leonardo da Vinci that he “awoke too early in the darkness, while everyone was still asleep”. If Leonardo was, as the renowned art historian Sir Kenneth Clark so appropriately called him ‘the most relentlessly curious man in history’, he has proved that he is also the man about whom we are also relentlessly curious even today.

It was he who started dissecting in solitude the stinking corpses of executed criminals and indigent hospital patients, so that he might better comprehend the body’s mysteries, even before the era of Renaissance. Born in 1452, he was at once a painter, architect, mathematician, city planner, biologist and researcher in optics, while at the same time a civil, military and hydraulic engineer. He was a gifted athlete, a fine musician and a talented singer, but above all he was overall a moral philosopher whose insights into nature and the human conditions were often profound.

Da Vinci in 21st century surgery
Leonardo da Vinci probably never thought that he would revolutionize cardiac surgery. Almost 500 years after da Vinci’s death, intricate diagrams of the human heart made by him have inspired a British surgeon to pioneer a new way to repair damaged hearts. Francis Wells, a cardiothoracic surgeon from Papworth hospital, Cambridge felt that Leonardo’s observation of the way the heart valves open and close was revelatory. Wells, based on da Vinci’s painting, pioneered a revolutionary procedure to repair the mitral valve without altering the normal diameter, which was the standard procedure. He has successfully repaired 80 patients of floppy mitral valve,[1]

Da Vinci invented the first robot and thus, laid the foundation of robotic surgery. Intuitive Surgical of Sunnyvale, California has manufactured a machine called ‘Da Vinci Surgical system’, often referred to as the surgical robot. Da Vinci’s microtools are snaked inside the body through tiny incisions and the surgeon has a three-dimensional magnified view of the operation and has his hand movements translated into the precisely controlled movements of the microtools for manipulating, cutting, cauterizing or suturing tissues. By 1997, Intuitive Surgical had a prototype “Mona” named after da Vinci’s Mona Lisa. Intuitive took Mona to Belgium for human clinical trial on procedures like peripheral vascular surgery. Although the da Vinci system has not been approved by the Food and Drug Administration, the first experimental remote-controlled cardiac bypass in the United States took place in September 1999.

Da Vinci and surgical anatomy
Da Vinci was a member of the Guild of St. Luke the Painter, which was associated with the Guild of Physicians and Apothecaries based at the hospital of Santa Maria Nuova in Florence. His connection gave him access to cadavers and he conducted more than 30 autopsies, between 1489 and 1513, often working by candlelight in the crypt of a church. He described how often ‘…. might be deterred by the fear of living in the night in the company of these corpses, quartered and flayed and horrible to see’. Leonardo drew many images of the human skeleton and was the first to describe the double S form of the backbone and was also first to investigate the spinal stability. He was the first to draw the bones of the hand and face correctly. Before Leonardo, the movement of supination was always given as a function of the muscle now described as brachioradialis. Leonardo in a series of annotated drawings made between 1505 and 1510, made it abundantly clear that the biceps brachii was the principal supinator, in addition to its action as a flexor of the elbow. He also studied the inclination of the pelvis and sacrum and stressed that the sacrum was
not uniform, but composed of five vertebrae. He was also able to represent exceptionally well the human skull and cross-section of brain (which he dubbed one of body’s “motors”). Da Vinci used all his knowledge as artist, sculptor and researcher in his personal quest for the location of the senso comune or soul. He believed that memory and soul are found just above the optic chiasma in the anterior portion of third ventricle. Leonardo’s pioneering research into the brain led him to the discoveries in neuroanatomy (such as frontal sinus and meningeal vessels) and neurophysiology (he was the first to pith a frog). He drew many images of the lungs, mesentery, urinary tract, sex organs and even coitus [Figure 1]. He was the one of the first who drew the fetus in the intrauterine position – though he drew the curled figure inside the uterus of a cow (like some ancient Greek philosophers, he believed human and animal organs were interchangeable). He was the first to observe and comment on the fetal membranes – the chorion, amnion and allantois [Figure 2].

Maxillary sinus surgery has its root from Leonardo da Vinci. In 1489 he was the first to prepare and draw an anatomical specimen of the paranasal sinuses. The drawing, however, only became accessible to scientific evaluation as late as 1901. Leonardo had drawn the earliest known drawing of the vermiform appendix and commented - ‘The appendix, of the colon, is part of the caecum and is capable of contracting and dilating so that excessive wind doesn’t rupture the caecum’. He disproved the belief that the heart was not a muscle and showed it consists of four chambers and not two, as was commonly thought. He also suggested that arteries fur up over a lifetime, creating a risk for coronary heart disease. The painting of Mona Lisa is credited with the first evidence showing Xanthelasma (over her left upper eyelid) and lipoma (over the dorsum of the right hand). These findings in a 25-30-year-old woman, who died at the age of 37, are now leading researchers to speculate that Mona Lisa died of hyperlipidemia. It has been established that eddy currents generated by the sinuses of Valsalva play an important role in the physiologic closure of the aortic valve. This fact was well represented and documented by da Vinci in his words and drawings. In 1513, he drew and described a case of atrial septal defect. He also subscribed to the Galenic theory of flux and reflux through the veins. It is also universally accepted that he was first to identify the anatomy of bronchial circulation. In 1489, da Vinci began to focus on the anatomy of the eye and optic nerves. In a review by Schultheiss et al from Germany, Leonardo’s genitourinary drawings were systematically reviewed with reference to the venouretic reflux and urinary sphincter mechanisms. The Mona Lisa syndrome is defined as facial muscle contracture that develops after Bell’s palsy when the facial nerve has gone partial Wallerian degeneration and has regenerated.

Da Vinci’s surgical anatomy interpretation was not always correct. He somehow believed that blood was consumed by muscles and that the semen originated in the brain. Leonardo’s observation on the inheritance of skin color...
is also of great interest. He quoted - "The black races of ethiopia are not the product of sun, for if black gets black with child in Scythia, the offspring is black; but if a black gets a white woman with child the offspring is gray. And this shows that the seed of the mother has power in the embryo equally with that of father".

**Da Vinci and cosmetic surgery**

Leonardo da Vinci’s contribution to the development of artistic anatomy is still the most important guide for plastic surgeons. He sketched and measured many faces and figures to determine geometrically what he called ‘the divine proportions’ [Figure 3]. He wrote - ‘the distance from the chin to the nose and from the hairline to the eyebrows are equal, each of them to the height of the ear and to one-third of the face’ and ‘From the edge of the orbit to the ear, there is the same distance as the length of the ear, in other words one-third of the head’. These guidelines still form the basis of all cosmetic plastic surgery widely practiced today.

Leonardo’s injection of hot wax into the brain of an ox provided a cast of the ventricles and represents the first known use of solidifying medium to define the shape and size of an internal body structure. [10]

**Critical analysis of Da Vinci**

Based on Da Vinci’s claim on the experiment on the bovine eye to study the internal anatomy of eye, Hilloowala repeated the same in his laboratory at West Virginia University. He concluded that the present knowledge about the lens is at variance from his finding, not because he didn’t carry out the experiment, as suggested by some modern authors, but because of the limitations of the technique available to him at that time. [11] In another study, the anatomical drawings of Leonardo da Vinci on female external genitalia and the fetus, particularly those concerning the umbilical cord were reviewed and it was seen that although he described accurately the position of the uterine blood vessels and the relationship between the pelvic organs, his drawing and description of the female external genitalia and human placenta were incorrect. Da Vinci believed that the human placenta had cotyledons like that of the ungulate uterus. The author concluded that Da Vinci’s misunderstanding was probably because he was only able to perform one anatomical dissection of a pregnant woman and fetus and therefore his knowledge was limited. [12]

Roostad studied all of Leonardo’s published texts and suspected that Leonardo might have suffered from dyslexia. [13]

**CONCLUSION**

Leonardo da Vinci finally did introspection of his work and commented ‘I have offended God and mankind because my work didn’t reach the quality it should have’. This only shows that he was born far ahead of his time. He is aptly regarded as the ‘hidden father of modern anatomy’. Da Vinci created about 750 anatomical drawings and planned an anatomical atlas of the stages of man from the womb to the tomb, though that was never completed.

"Sometimes the heavens endow a single individual with such beauty, grace and abilities that whatever he does, he leaves all other men far behind, thus demonstrating that his genius is a gift of God and not an acquirement of human art."

- Giorgio Vasari

**REFERENCES**