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Review Article

Historical Evolution of Anatomy

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Abstract

Anatomy is an old medical study. Anatomical techniques are centuries-old knowledge that has evolved to accommodate modern changes. Early anatomists were morphological explorers and observers. Early scientists saw anatomy as an essential subject for understanding the form and functions of the body, as well as the causes of pathologies. They practiced it on purpose. This article sought to analyse developments in the area of anatomy across time, depicting important changes in anatomical practice through linkage with historical periods and their contributions.

Keywords: Anatomy; Evolution; History; Medical; Pathology

Introduction

Anatomy as a term has been derived from the Greek verb "anatomein," which means "to cut open, to dissect". The most important process of study of anatomy is the opening, dissecting and describing the individual body parts.

The beginnings

3RD CENTURY B.C.

Anatomy is the oldest scientific discipline of medicine. The first scientific documented dissection on the human body was carried out in the third century B.C. in Alexandria. During that period, anatomists explored anatomy through dissections of animals, primarily pigs and monkeys.

Aelius Galenus or Claudius Galenus was a Greek physician, surgeon and philosopher in the Roman Empire. He was the most accomplished among the medical researcher of various scientific disciplines i.e. anatomy, physiology, pathology, pharmacology and neurology as well as philosophy and logic who persuaded to develop the disciplines [1].

Because of Roman law that prohibited the dissection of human cadavers (since roughly 150 BCE) badly affected the interest of Galen in human anatomy. Because of the restriction, Galen performed anatomical dissections on living (vivisection) and dead animals, mostly focusing on primates. He strongly believed that the anatomical structures of primates closely resembled to those of human beings. Galen elucidated the anatomy of

the trachea and was the first to demonstrate the larynx and quoted that this is responsible for production the voice (Voice producing organ). Galen also tried to inflate the lungs of dead animals by using bellow pumps [2].

Another remarkable contribution of Galen to medicine was on the circulatory system. Earlier, it was believed that oxygen was carried by the arteries rather than blood. He was the first to appreciate the distinct differences between venous (dark) and arterial (bright) blood. Galen also hypothesized about the nature of the circulatory system. He postulated that blood originated in the liver, similar to the teachings of Hippocrates [3-5].

His anatomical experiments on the animal models led him to make complete anatomical perception of the circulatory system, nervous system, respiratory system, and other structures. Galen was also a pioneer in research about the human spine. By doing repeated dissections and vivisections of animals he accurately pioneered the detailed and key findings on human spine, spinal cord, and vertebral column. He also played a major role in the discoveries of the Central Nervous System [6-8].

At the same time, he also led to some inprecisions, most importantly his observation on uterus anatomy where he described it to resembled like that of a female dog. In spite of his incorrect observations on human reproduction and reproductive anatomy, he came very close to defining the ovaries as analogue to the male testes. Reproduction was a controversial topic in Galen's lifetime, as there was much debate over if the male was solely responsible for the seed, or if the woman was also responsible [9].

Modern age

15TH/16TH CENTURY

A well-known Renaissance artist and scientist, Leonardo da Vinci (1452-1519), on the basis of his repeated anatomical dissections of human corpses, documented highly detailed famous anatomical sketches. Leonardo's artistic interest on anatomy led him to perform various dissections and facilitated him to move to Milan (at the time a centre of medical investigation) by 1490s. His sharp eye interest on anatomy, structure of human body facilitated him to work in this independent area of research. Leonardo became fascinated by the *figura istrumentale dell' omo* ("man's instrumental figure") and he sought to comprehend its physical working as a creation of nature. Over the subsequent two decades, he did many anatomical dissections on the dissection table in Milan, then at hospitals in Florence and Rome, and in Pavia, under the direction of the young professor of anatomy, Marcantonio della Torre. Unfortunately during his lifetime, none of Leonardo's discoveries were published. Although his methods of demonstrating the dissection of muscles in layers (his "plan, section, and elevation" techniques) became widely disseminated and incorporated in the first comprehensively illustrated Renaissance treatise, Andreas Vesalius' *De humani corporis fabrica*, published in Basel in 1543 (53.682) [10,11].

Vinci and Marcantonio not only attended the dissections performed by their medically trained friends, but also picked up the scalpel themselves to do dissections with the aim to illustrate the body in all its natural glory. They depicted body and muscles, bone structure, the skeleton and the skin in the most majestic and realistic way.

Leonardo da Vinci was so passionate to study the human body that he used to steals bodies by climbing cemetery walls, and dragging them into his studio during night where he used to dissect them and use them as models for his sculptures.

From the 16th century onwards

The work of surgeon and anatomist "Andreas Vesalius" laid the foundation for the genuine science of anatomy. Author of "De Humani Corporis Fabrica Libri Septem," one of the most important works on human anatomy, Andreas Vesalius was a physician and anatomist in the sixteenth century. Male and female anatomical images were featured in the Fabrica. Diagrams of uteruses containing whole fetuses were also presented. Based on his observations from corpses and dissections, Vesalius was among the first doctors to precisely document and illustrate human anatomy, which contributed to a better knowledge of the human body and improved surgical methods. Many people consider Vesalius to be the father of modern human anatomy [12,13].

Vesalius produced De humani corporis fabrica librorum epitome ("Abridgement of the Structure of the Human Body") subsequent to the publication of the Fabrica. Eleven woodblock prints that incorporated Fabrica illustrations as well as depictions of the skeleton, muscles, nerves, veins, and arteries made up the Epitome.

Unlike the Fabrica, the Epitome featured layers of muscles in their resting positions, ranging from superficial to deep, which made it easier for surgeons to operate on and cure wounds [14].

Vesalius gave an account of what he saw when human bodies were dissected in public. Through the process of dissecting human corpses and meticulously preparing muscles, tendons, and nerves, Vesalius was able to identify over 200 inaccuracies in Galen's anatomical works. With his comprehensive scientific studies of human bodies, the young professor of medicine not only revolutionized anatomy, but consequently, the whole science of medicine.

Anatomists started investigating and arguing for the proposition that anatomical study may advance the frontiers of natural philosophy in the late 16th century. The majority of students, however, were less concerned with the expansion of anatomy knowledge and more focused on the application of the subject. Students' criticism of professors like Girolamo Fabrici demonstrated their preference for the dissection technique above the concept of anatomy.

In the early sixteenth century, anatomical theatres gained popularity as a method of teaching anatomy. Founded in 1594, the University of Padua was the first and most well-known theatre. Italy consequently rose to prominence as a hub for human dissection. Everyone was welcome to attend the show, which drew viewers from all over to hear lecturers on human anatomy and physiology. Visitors "were fascinated by corporeal display, by the body undergoing dissection" [15]. The majority of instructors delegated their dissections to others. Rather, they paid men to cut while they sat in seats above the bodies. Professors would describe the various anatomical components to students and spectators seated around a table in a circular arena like a stadium. Throughout the 16th century, anatomy theatres became more and more popular, and procedures were changed to accommodate students' interruptions. Pupils started robbing and damaging cadavers instead of just being excited to take part. As a result, the students were told to remain silent and faced consequences if they interrupted the dissection. Additionally, preparatory lectures were required to convey the concept of "subsequent observation of anatomy". Lectures and dissections constituted the format of the demonstrations. The lectures would concentrate on the philosophical issues surrounding anatomy, while the dissections would highlight the art of autopsy and vivisection. This exemplifies how anatomy was understood to be the study of the "body as an extension of the soul" in addition to the study of structures.

17th Century

Renaissance anatomists were motivated by a passion for art, and public interest in anatomy was growing. Physicians and the general public alike are becoming more and more interested in seeing the human body for themselves. The Greek expression "To see with one's own eyes" is where the word "autopsy" originates.

The printing press's invention made it easier for ideas to be shared. One did not have to be a Latin specialist to participate in the study of anatomy because it involved observation and drawings, and the anatomist's fame was correlated with the caliber of his drawings. Like Rembrandt, a number of well-known artists studied anatomy, went to dissections, and sold their drawings. For the first time, anatomy classes at prestigious colleges could be taught mostly using illustrations rather than Latin. Despite what is commonly believed, the Church did not oppose or prevent anatomical research.

Dissections could only be performed by certified anatomists, and even then, only once a year. Like a scholar-friendly circus act, these dissections were sponsored by the city councilors and frequently required an admission price. In numerous European towns, including Padua, Paris, London, Amsterdam, Copenhagen, and Copenhagen, local government employed Royal anatomists, or an equivalent position. Nicolaes Tulp did, in fact, serve three terms as mayor of Amsterdam. Attending dissections was allowed, even though it was a dangerous and unpredictable profession dependent on the supply of new bodies. The demand for human cadavers for dissections surged as a result of the availability of printed anatomy texts from France and Italy. Nevertheless, the tremendous demand for bodies was not being met by the available supply of bodies.

In numerous cities, anatomical theatres were constructed. Attendees of both wealth and poverty would swarm the public dissection sessions.

18th Century

Some anatomists create enduring works of art from their specimens by using their dissecting techniques in a conventionally

artistic manner. Honoré Fragonard creates enduring works of art from his anatomical specimens. He gives them injections of colored wax, which gets hard inside the blood vessels. The leftover tissues are varnished when they have dried up. At the Ecole Nationale Vétérinaire d'Alfort, close to Paris, France, his artwork is still on exhibit.

The first whole-body specimens are made by anatomical artists in the eighteenth century, and they are then dried and polished. Certain artifacts from that era have metal alloys that are melted and then injected while still hot into the arteries.

Honoré Fragonard was a meticulous artist, a skilled artisan, and a genius in his own right. His area of expertise was the construction and conservation of écorchés, or anatomical models. The translation of this is "flayed figures." In the eighteenth century, medical students considered them indispensable due to the scarcity of remains for dissection. Écorchés were human models in which the skin was removed to reveal the bones, muscles, and blood veins. They were constructed from a variety of materials, including wood, wax, plaster, ivory, and bronze. Fragonard crafted his from dead bodies. He did not reveal his preservation techniques.

19th/20th Century

After the principles of human macroscopic anatomy-the study of dissected organs-is established. Anatomical scholarship gained access to the microscopic anatomical realm as the study of anatomy became more specialized. Anatomy continues to pique people's curiosity for several ages. Dissections are not open to the public until the 19th century, when anatomy is recognized as a science. Millions of individuals are inspired to pursue an interest in anatomy by the BODY WORLDS displays, which are successful in reviving a public anatomy culture. Eventually, anatomical theaters gave way to classrooms in the 19th century, which decreased "the number of people who could benefit from each cadaver".

Frank H. Netter (1906-1991), a famous American surgeon, grew up with dream to become an artist but became surgeon. He was a celebrated medical illustrator who continued doing freelance art during his medical training. In the initial part of his career, Netter started doing medical art to supplement his income as a medical practitioner. But very soon he embraced medical illustration as a fulltime profession and started working for pharmaceutical companies. The methodical study of the human body's forms served as the foundation for all of Netter's pictures, and it guided his extensive and profound knowledge of medicine. He believed that a medical illustration would be useless if it failed to make a medical point, regardless of how skilfully it was produced. Finding a medium ground between artistic clarity and pedagogical intricacy was his greatest achievement. Because of how well-liked his illustrations were among his peers, Netter's work was eventually collected for the first time. Netter's Atlas of Human Anatomy, compiled from his earlier illustrations, was released in 1989. The 16-language atlas quickly rose to prominence as the most used Atlas of "Anatomy" in American medical schools. Netter's sublime lifelike artwork enabled fast production of computer assisted 3D volume-rendered images that are being used as templates or backgrounds for preparing high quality anatomical illustrations. Till the end of 19th century, anatomical illustrations solely relied on handmade sketches/diagrams [16].

20TH Century

During the 20th century use of illustrations in anatomy considerably increased and it was revolutionized by the emergence of two new entities; medical images and photographs. Medical imaging began in 1895 with Wilhelm Conrad Roentgen's discovery of the X-rays. The use of X-ray films in teaching anatomy was an important landmark and it particularly helped in understanding of surface anatomy. In the early part of the 20th century, two dimensional plane X-ray films were available depicting the anatomy of the chest and bones of the human body. From 1920s contrast X-ray images were available in the form of barium swallow and barium enema, which provided anatomical details of different parts of the gastrointestinal tract.

X-ray tomography (analog tomography) was introduced in the 1940s, allowing visualization of tissue slices without the over or underlying tissues being seen. In the 1950s X-rays formed the basis of contrast enhanced angiographic images which helped to understand the anatomical distribution of the arteries in the human body particularly that of the coronary and carotid arteries. During the 1960s ultrasound technology came into prominence and its clinical applications were explored. Over this period, sonography was recognized as the primary imaging technology in the field of obstetrics and was used to obtain images of the developing fetus

during pregnancy. Echocardiography was acknowledged as an important tool which provided an overview regarding the anatomy of the cardiac chambers. A major breakthrough was achieved in the 1970s with the advent of computed tomography (CT) followed by magnetic resonance imaging (MRI). The entry of computers into the world of medical imaging in the early 1970s contributed to further development of these two new technologies. CT was a major advance as it allowed multiple tomographic images (slices) of the desired tissue to be acquired. Initially CT scanners were slow in acquiring images but with the advent of spiral CT in the mid1980s, images of an entire anatomical region could be obtained in seconds. In fact, CT imaging is used in present day to virtually dissect a human body in multiple planes. After its introduction MRI was used to obtain cross-sectional images involving the soft tissues in the human body. Initially these images had low spatial resolution; however, the introduction of super conducting magnets (initially at 1.5 Tesla and now at 3 Tesla) over the 1980s and 1990s has led to the production of high resolution images with increased clarity. The introduction of CT and MRI together with advanced computer technologies proved to be a watershed event in the evolution of anatomical illustrations. Prior to these technological innovations, learning and understanding anatomy was limited by the traditional two dimensional images. Both CT as well as MRI provided anatomists with a large volume of cross-sectional image datasets which could be transformed into 3D images of anatomical structures by volumetric reconstruction. One of the numerous advantages of digital photography is the opportunity of evaluating the picture immediately after it has been recorded to analyze technical elements such as sharpness, illumination, color and location of the anatomical structure. The ability to take consecutive or serial photos is another feature of digital technology that helps professionals capture anatomical features with amazing accuracy. Because publishing technology has become ubiquitously digital, all pictures used as anatomical illustrations nowadays are digital in nature or become so throughout the printing process. Modern technology makes it possible to provide anatomical pictures online, expanding its reach among anatomists across the globe. By carefully choosing a Web-based dataset of anatomical photos, processing them, and then presenting them, educational institutions and students can create their own 3D interactive virtual anatomy models, which are an effective teaching tool in the modern era.

Anatomical revolution in India

The Paleolithic Era, the Indus Valley Civilization, the Vedic Period, the Islamic Dynasties, the Current Colonial Era, and finally Independent India are all mentioned in the history of anatomy in India. Despite disputes and times of latent periods, the study of anatomy has remained fascinating.

Of all the medical sciences, anatomy is the most significant and ancient. In ancient India, the primary sources of anatomical knowledge were animal sacrifices, accidental discoveries of incorrectly buried dead, and medical exams of patients. The Indus Valley Civilization period's archeological findings reveal cave drawings of animals with highlighted crucial spots that, if hit, would have killed the creatures. This is unmistakable proof of your initial surface anatomy lessons. The heart was described in the Vedas as "Lotus with nine gates," which is quite accurate given the modern understanding of the heart. The heart does indeed resemble a lotus bud when held with its tip upwards because it has nine apertures in total-three in the night atrium, four in the left atrium, and one in each of the right and left ventricles. The Upanishad, written before the invention of microscopes, contains an excellent account of the embryo. It is quite remarkable because it nearly perfectly aligns with what is now understood about embryology. For instance, the embryo develops into a vesicle known as a "Budbuda" seven nights after sexual activity, according to the Upanishads. An embryo that is seven days old is vesicular and is currently referred to as a blastocyst.

There was a veterinary cult on the Indian subcontinent as early as 3,000-4,000 years ago, according to Indian literature. Veterinary medicine instruction was added to medical school curricula in the post-Vedic era. There is proof that throughout the reigns of King Ashoka (237-232 BC) and Chandra Gupta Maurya (300-298 BC), veterinary clinics and dispensaries existed. In the past, veterinarians were referred to as Salihotriya, after the renowned expert on horse medicine, Salihotra. Salihotriya is the source of the veterinarian title Salutri.

The post-upanishadic period is considered the "The Golden Age of Indian Medicine". Ayurveda, the science of life (Ayur=long life; Veda=science) was evolved during this period by two great proponents -Susruta and Charaka. In Susruta's work, it is evident

that considerable thought was given to anatomical structure and function, as Susruta was a proponent of human dissection;his texts include a systematic method for the dissection of the human cadaver. In the Sanskrit writings of Susruta Samhita, there is a complete section "Sarira Sthana" devoted to Anatomy. Besides gross anatomy, embryology and histology are also dealt with, which indicate a comprehensive study of Anatomy. The Sarira-Sthaka discusses mainly anatomy, embryology and technique of dissection. During this period the ancient Indians also pioneered in human dissection. Susruta listed the body's number of muscles and bones. He talked about the lungs, stomach, intestines, bladder, uterus, rectum, and four pairs of cranial nerves in addition to blood arteries. He went so far as to explain the joints and how their injuries affected them. Susruta is rightfully referred to as "The father of Surgery," and he is also simply referred to as "The father of Applied Anatomy."

Medical schools were founded in the late 19th century in the major cities of Madras, Calcutta, and Bombay while under British administration. When Madras Medical College first opened its doors in 1835, it allowed women to enroll in order to address the female population, which had historically shied away from receiving medical care from trained male experts. Students were taught muscles and bones by Dr. Mortimer of Madras using paste-board models. He framed a copy of Mortimer's Manual of Anatomy, a textbook for practical anatomy. "Cunningham's Manual of Practical Anatomy" comes before this manual.

The introduction and development of Medical and Veterinary Anatomy took side by side, in fact, keeping in view the literature the animal anatomy became the base for the foundation of human anatomy.

The introduction of formal veterinary education in India was establishment in 1862 as an army veterinary school in Pune. With this many departments of veterinary education including veterinary anatomy were introduced and formed the base of veterinary surgery and physiology. The first civil veterinary school was started in Babugarh (Hapur), in Uttar Pradesh, in 1877. These schools had the limited objective of training Indians to serve as assistants in remount depots and on military farms. Subsequently, the first veterinary college was started at Lahore, now in Pakistan, in 1882. The establishment of a veterinary research laboratory in India was recommended in 1885 and actually took place in 1889 at Pune. (In 1983 this laboratory was moved to Mukteshwar in the Kumaun Hills of Uttar Pradesh because the congested surroundings of Pune made it unsuitable for working with the highly virulent disease rinderpest.) The Bombay Veterinary College came into existence in 1886.

A civil veterinary department was established in 1881. With the expansion of the activities of civil veterinary departments in several states, veterinary colleges arose in different centres: for example, Calcutta in 1893 and Madras in 1903.The Madras Veterinary College took the lead, and in 1936, with the concurrence of Madras University, the Bachelor of Veterinary Science degree program began. Subsequently veterinary degree programs were started in other states, including at Patna, Mathura, Bangalore, Trichur, Hyderabad, Tirupathi, Ludhiana, Anand and so on. The veterinary science actually cannot be imagined without the knowledge of veterinary Anatomy.

Conclusion

It is vital to note that Anatomy has evolved in context and substance over time, and these evolutions have had an impact on philosophy at each step. Anatomy is an ancient medical science that has evolved over time to reflect technological advancements. Early scientists saw anatomy as an essential subject for understanding the form and functions of the body, as well as the causes of pathologies. They practiced it on purpose. The history of anatomy reveals that it was discovered by practicing physicians and surgeons, indicating that they could only practice medicine after studying anatomy. The source of knowledge of anatomy were animal or human beings, as evidenced by this review.

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