

A Journey of Cadaveric Preservation from Ancient Cultures to Modern Period

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Abstract

Cadaveric dissection serves as an educational tool for training of health science students and also an important research tool. Hence proper preservation of the cadaver is important and it is done with the help of embalming. Embalming is the art and science of preserving human remains by treating them with chemicals to forestall decomposition. In this article, we look at how embalming has evolved from ancient cultures to modern times. In Ancient Cultures, Egyptians embalmed the body for eternal life of the soul. For this, they divested the body of all moisture for preservation and removed organs except the heart because they believed that heart is where the soul resides. Later the body was wrapped in layers upon layers of linen sheets creating a new being of divine character and able to live forever. Different methods of embalming were also seen in Spain, Northern Greece and China. In the Middle Ages embalming became widespread in Europe. Evisceration was carried out and body cavities were filled with herbs and spices; then the body was sewed and wrapped in waxed cloth. The period

of the Middle Ages and the Renaissance is known as the 'Anatomists' Period of Embalming'. New techniques like injections into hollow structures and injections of the vascular system with different types of solutions started. Arsenic was one of the contents used, funeral embalming began and in 1920 formaldehyde was first used in the embalming fluid. The period from 1861 is known as the 'Funeral period of Embalming' as there was separation of the fields of embalming by undertakers and embalming for medical and scientific purposes. The bodies of Abraham Lincoln and Vladimir Lenin were embalmed in this period. In 'Modern Embalming', the embalming fluid comprises different kinds of chemicals like preservatives, disinfectants, buffers, humectants, anticoagulants, dyes and masking agents or deodorants. Today embalming has come a long way and is being replaced with processes like 'Plastination' and 'Cryopreservation'.

Keywords: Cadaveric Dissection, Embalming, Decomposition, Ancient Cultures, Middle Ages, Anatomists' Period of Embalming, Funeral period of Embalming, Modern Embalming, Plastination, Cryopreservation.

Introduction

Cadaveric dissection is one of the oldest methods of learning human anatomy in medical colleges.

Students of health science courses either learn on prosected specimens or dissect themselves. Dissection not only serves as an educational tool for training of surgeons but is also an important

research tool. For training of health workers, there is nothing better than a human body. For Anatomists it is defined as a student's first teacher. It can never be considered as a simple biological model because it was once a living human, it shows variations and gives a student a three dimensional view along with an excellent tactile experience.¹ Never the less, the use of cadavers for research and teaching and training purposes has raised several concerns like restricted availability as well as ethical reservations; these include health hazards and religious sentiments of people involved.

Proper preservation of the cadaver is an important requisite for cadavers being utilised for research and training purposes. This is done with the help of embalming. Embalming is the art and science of preserving human remains by treating them with chemicals to forestall decomposition. Embalming is carried out by using chemicals like formaldehyde to retard decomposition as long as possible. The harmful effects of formaldehyde are another concern for those against dissection.²

The aim of this article is to give a synopsis of the history of embalming in order to understand how embalming has evolved from ancient cultures to modern times.

Ancient Cultures

While studying the history of embalming in ancient cultures it is of vital importance to know the reasons behind cadaver embalming in those times. Ancient Egyptian cultures held religious beliefs that 'eternal living' was linked with a well preserved and well-maintained body. According to the understanding of the ancient Egyptians themselves, the preservation of the human body was necessary so that the soul had a place on earth to which it could return in order to receive offerings and thus survive eternally. If the body decomposed the person would be excluded from living till eternity and wouldn't have an afterlife. Hence Egyptians divested the body of all moisture for preservation and removed organs except the heart because they believed that heart is where the soul resides. The body cavities were then filled with chemicals and spices to prevent any bacteria from growing. The body was then left covered in salt to become dry. After 40 days, the body would be wrapped in linen bandages while chanting spells. A mask was put over the head of the mummified body so that it could be recognised in the afterlife. These religious beliefs originated from the fact that when buried under certain conditions, natural preservation

took place and the bodies did not decompose. Natural means of preservation comprised freezing, desiccation either by dry heat or dry cold, or the specific nature of the soil at the burial site.³

The Chinchorro culture of Atacama Desert of present day Chile and Peru are among the earliest cultures known to have performed artificial mummification as early as 5000–6000 BCE. Artificial means of preservation included the application of simple heat or cold, powders of sawdust mixed with zinc sulphate, immersion in alcohol, brine, etc.⁴

With increasing population, techniques of preservation were enhanced in Egypt starting as early as 3200 BC. Specialized persons were in charge of these activities; they became members of the priest caste. With time the priests brought about two main advances from natural means of preservation to sophisticated embalming. One they started using materials like natron, herbs, cedar oils, resins, incense and gums. Secondly, they introduced evisceration. These two methods ensured preservation for a long time. The body was wrapped in layers upon layers of linen sheets.⁵ It is important to understand, however, that it was not just the preservation of the human bones and tissues that was intended. The wrapping with linen changed forever the shape of the human body and created a new being which was believed to be of divine character and able to live forever.⁶ Another method used was immersion in honey which was introduced by Persians. The cadaver of Alexander the Great was treated in this way, the need being long distance transport.⁷ The ancient Tibetans and Nigerian tribes predominantly used large quantities of alcohol concentrate, potash, herbal leaf (African basil) and kernel oil.⁸ The oldest recognized artificial preservation in Europe has been found in Spain in the dolmenic burial 'La Velilla' in Osorno where 5000-year-old human bones have been discovered, judiciously covered by pulverized cinnabar.⁹ The occurrence of resins from coniferous and pistacia trees, myrrh and other spices in a partly mummified body dating to 300 A.D found in Northern Greece, point to preservation methods used in Greek and Roman times.¹⁰ In China, the extremely fresh-looking corpse of Xin Zhui of the Western Han Dynasty (between 187 and 145 BC) was discovered in 1971. When workers opened her tomb, they found it to be remarkably well preserved. Her skin hadn't decayed and her muscles and tendons were still malleable enough for her joints to flex. The cadaver was found immersed in liquid, the composition of which is still unknown.¹¹

Middle Ages

Embalming became widespread in Europe and the methods used have been well maintained in the writings of contemporary physicians, like Peter Forestus (1522–1597) and Ambroise Pare (1510–1590). The methods were defined as evisceration, washing with cold water and aqua vita, filling cavities with consecutive layers of Aqua vita moistened cotton, and powder of herbs and spices like aloes, myrrh, wermut, rosemary, pumice, majoran, storacis calamata and zeltlinalipta muscate; then sewing the body, and finally wrapping it in waxed cloth. In later years embalming included evisceration, immersion of the body in alcohol, insertion of preservative herbs into incisions formerly made, and wrapping the body in tarred or waxed sheets.¹²

Period of Renaissance

The period of the middle ages and the renaissance is known as the 'Anatomists' Period of Embalming'. Dissection was prevalent and cadavers were required for dissections. Embalming progressed significantly as it became influenced by advances in Medicine.¹³ Embalming methods became more sophisticated. New techniques like injections into hollow structures started but injections of the vascular system were still underway. Alessandra Giliani used an arterial injection of coloured solutions which hardened with time.¹⁴ Leonardo da Vinci's (1452–1519) embalming fluids were mixtures of turpentine, camphor, oil of lavender, vermilion, wine, resin, sodium nitrate, and potassium nitrate and injection of wax to the ventricles.¹⁵ Jacobus Berengar (1470–1550) injected warm water into veins, Bartholomeo Eustachius (1520–1574) injected warm ink. Reinier de Graaf (1641–1673) added mercury. Jan Swammerdam (1637–1680) injected a wax-like material for hardening.¹⁶ Frederik Ruysch (1638–1731) injected liquor balsamicum a prepared chemical preservative which contained clotted pig's blood, Berlin blue and mercury oxide.¹⁷ His work of embalming was so nearly perfect that people thought the dead body was actually alive

The Scottish surgeon William Hunter was the first to use an arterial injection of a number of oils like turpentine, oil of chamomile and oil of lavender with Vermillion which was used as a dye and a preservative. His brother, John Hunter, applied these methods and advertised his embalming services to the general public from the mid-18th century.¹⁸ In France also a number of approaches were tried which were fairly successful. Cuvier (1769–1832) used pure alcohol, Thenard

(1777–1857) used alcoholic solution of dichloride of mercury, Chaussier (1746–1823) immersed eviscerated bodies in a solution of dichloride of mercury, and Sucquet (1840–1870) used 20% zinc chloride solution. Jean Nicolas Gannal (1721–1783) became a funeral embalmer. His embalming fluid contained a solution of acetate of alumina among other substances. His formula was patented and he was the first to document and publish his studies on embalming.¹⁹ The British, French and Italian scientists perfected arterial and cavity embalming techniques, thus aiding the embalming fluid from spreading to every part of the cadaver. After Lord Nelson was killed in the Battle of Trafalgar, his body was preserved in brandy and spirits of wine mixed with camphor and myrrh for over two months. At the time of his state funeral in 1805, his body was found to still be in excellent condition and completely plastic.²⁰ In Italy, arsenic solutions were used for arterial injection successfully by Guiseppe Tranchina (1797–1837). This technique was the very first documented method that did not involve evisceration. Until the early 20th century, embalming fluids often contained arsenic. There was concern about the possibility of arsenic from embalmed bodies contaminating ground water supplies and legal concerns that people suspected of murder by arsenic poisoning might claim in defense that levels of poison in the deceased's body were the result of post-mortem embalming and not homicide.²¹ Alfredo Salafia (1869–1933); was not an anatomist but only an embalmer. He embalmed several important persons, but his most prominent body was Rosalia Lombardo, an Italian child born in 1918 in Palermo, Sicily who died of pneumonia on 6 December 1920. She is extremely well preserved, and all of her organs are still intact. Due to an optical illusion involved the way light filters into the glass coffin, many have observed that Rosalia opens and closes her eyes. The body is located in the Capuchin Catacombs of Palermo. Salafia left behind a hand written manuscript revealing that his solution was one of the very first formulas that contained formaldehyde.²²

Funeral Period

The period from about 1861 is sometimes known as the funeral period of embalming and is marked by a separation of the fields of embalming by undertakers and embalming (anatomical wetting) for medical and scientific purposes. Modern embalming for mere funeral purposes begun in 1861 in the American Civil War, to permit burial

without any urgency and to avoid the spread of infection. Thus, the corpses of dead Union officers were embalmed so as to return to their families. Military authorities also permitted private embalmers to work in military controlled areas. Cosmetic work was also permitted to reinstate bruised facial features.²³ The passage of Abraham Lincoln's body home for burial was made possible by embalming, and it brought the possibilities and potential of embalming to wider public notice. This type of embalming comprised elimination of blood and gases from the body and the insertion of a disinfecting fluid; the viscera was removed and immersed in an embalming fluid and then replaced in the body. The body and viscera are covered with a preservative powder. Fluid contained arsenic, creosote, mercury, turpentine and various forms of alcohol. Arsenic based solutions were generally accepted and frequently used as embalming fluid in the 19th and early 20th centuries but has since been supplanted by formaldehyde.²⁴ Some famous mummies of ancient times have been that of King Tutankhamun, an Egyptian pharaoh of the 18th dynasty. His mummy was discovered in 1922 and one of the members of the expedition died a few months after the discovery which stirred the legend of the 'Mummy's Curse'. The mummy of Ramesses II, Egypt's most powerful pharaoh is now on display in the Cairo Museum.²⁵ The mummification of Vladimir Lenin, the architect and first head of the USSR and father of Russian Communism, was carried out for the benefit of future generations since no process of mummification had ever been attempted before this, in modern times. Generations of Russian scientists have spent almost a century fine-tuning preservation technique that have maintained the look, feel and flexibility of Lenin's body. The body gets re-embalmed once every other year; a process that involves submerging the body in separate solutions of glycerol solution baths, formaldehyde, potassium acetate, alcohol, hydrogen peroxide, acetic acid solution and acetic sodium. Also, occasional parts of skin and flesh are substituted with plastics and other materials.²⁶

Modern Anatomical Preservation

Modern embalming is most often executed for better presentation of the deceased to friends and relatives, in medical colleges to preserve the dead bodies for the purpose of dissection for training and research and when the dead body has to be transported from one country to another for burial or cremation and the time taken in transit is such as

would ordinarily lead to decomposition.²⁷ It is also carried out when the dead body of some important personality has to be preserved for public viewing. Thus, embalming has evolved into a restorative and mortuary cosmetic art.²⁸

Today embalming involves arterial embalming, cavity embalming, hypodermic and surface embalming. The embalming fluid comprises different kinds of chemicals like preservatives, disinfectants, buffers, humectants, anticoagulants, dyes and masking agents or deodorants.²⁹ A new embalming technique developed by anatomist Walter Thiel at the Graz Anatomy Institute in Austria retains the body's natural colour, texture and plasticity after the process. Cadavers conserved by Thiel Method have greater antibacterial properties, no detectable odour, highly flexible joints and muscle and viscera colour appear natural.³⁰ Today there are institutes which carry out newer processes like 'Plastination' where tissues are replaced by polymers and 'Cryopreservation' where the body is preserved at sub-zero temperatures.

Conclusion

Preservation of a cadaver has evolved in a big way since ancient times. Preservation techniques like soft embalming by Thiel method as well as recent advances like Plastination and Cryopreservation hold much potential for more innovative advances in embalming techniques.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

SR drafted the manuscript, performed the literature review & SPS assisted with writing the paper.

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