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REVIEW PAPER

Embalming: The Art of Preserving the Dead

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ABSTRACT

Embalming is a process by which dead bodies are preserved by adding various chemicals that delay the putrefactive process. It has been practised since time immemorial by ancient Egyptians, the Peruvian Incas, the Hans Dynasty of China, during American Civil War to the modern day. In 1867, the German chemist August Wilhelm von Hofmann(1818 - 1892) and Alexander Butlerov (1817 - 1868) were credited with the discovery of formaldehyde whose preservative properties were soon discovered and subsequently became the foundation for modern methods of embalming, replacing previous methods and materials based on alcohol and arsenical salts. Legal requirements of practice vary geographically. In many places, embalming is not done by trained embalmers, but by doctors who while have the required anatomical knowledge, are not trained specialists in this field. Today, embalming is a common practice in North America and New Zealand while it is somewhat less frequent in Europe. In some countries, permits or licences are required; in others it is performed only by medical practitioners. The procedures applied may also vary depending upon expertise and environmental requirements.

Keywords*: Embalming, history, materials, procedures*

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INTRODUCTION

Embalming is the art and science (treatment) of preserving the dead body with antiseptics and preservatives to forestall decomposition.[1](*embalm-em·balm(m-bäm)tr.v. em·balmed, em·balm·ing, em·balms).* Embalming is the word for the old English phrase "*to apply balm"*and is derived from the Latin word "*emencapsulate"*and "*balming"* or "*balsam"*- any aromatic resin produced by certain trees of the mint family. The purpose is to keep them suitable for public display at funerals, for religious reasons, for medical, scientific and academic purposes such as their use as anatomical specimens. The basic goals of embalming are sanitization, presentation and preservation (or restoration). Embalming is distinct from taxidermy as embalming preserves the human body intact, whereas taxidermy recreates an animal, using only the creature's skin mounted on an anatomical form.[1]

HISTORY

In classical antiquity, the Egyptian culture had developed embalming to the greatest extent,as early as the first dynasty (3200 BC), specialized priests were in charge of embalming and mummification.[1]The Mummy of Tutankhamun discovered on 12th Feb, 1924 by English Egyptologist Howard Carter in tomb KV62 bears testimony to the ancient practice.[2] According to Herodotus of 450 BC, the Macrobians of ancient Egypt, who inhabited parts of the Horn of Africa, practised an elaborate form of embalming by preserving the bodies of the dead during the 1st millennium BC.[1]

Embalming in Europe became common in the industrialized regions especially during the Crusades in parallel with the Anatomists of the Renaissance. The period of the Middle Ages and the Renaissance are known as

the *Anatomists period of embalming.* It reached its peak during the British Empire and American Civil War, a period starting from 1861 known as the *Funeral period of embalming.* Embalming his first corpse in 1861, Dr. Thomas Holmes, the father of modern as well as American embalming, developed a technique that involved the draining of a corpse's blood and embalming it with a fluid made with arsenic for preservation and in the process performed over 4000 embalmings during the war.[1,3] In 1867, the German chemist August Wilhelm von Hofmann (1818-1892) and Alexander Butlerov (1817-1868) discovered formaldehyde which became the foundation for modern methods of embalming, replacing previous methods and materials based on alcohol and arsenical salts.[1]

EGYPTIAN PROTOCOLS

The Egyptians embalmed for religious reasons to help the dead enter the afterlife, because of the belief that in afterlife the decedent required a body. The protocol maintained was more or same along the entire Nile Valley;[1,4]

- The embalming process took about 70 days.
- The body was first taken to the tent known as *'ibu'* or the *'place of purification'*, and washed with good-smelling palm wine and rinsed with water from the Nile.
- An incision was made into the left side and the internal viscera except heart and brain were removed and placed in stone *canopic jars.*[5] Being centres of feeling and intelligence respectively, they were thought to be required in afterlife.
- The brain, accessed via the nose, was minced and pulled from the skull with hooks.
- The body cavity was next stuffed with natron salt (a naturally occurring mixture of sodium carbonate and bicarbonate in varying proportions and obtained from the dry alkaline lake beds or shores), the skull filled with resin, and then allowed to "cure" for a period of about 40 days.
- After that the body was again washed with Nile water, anointed with perfume and oil and packed with herbs, linen, and/or sawdust.
- Finally, the body was wrapped in linen and placed in a coffin for entombment.[1,4]

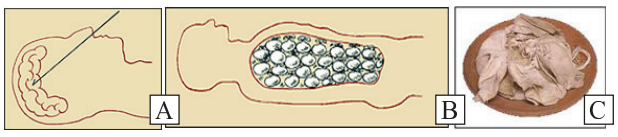


Figure 1 (A) Mincing of the Brain, (B) Body cavity stuffed with natron salts and (C) Linen wrappers.[1]

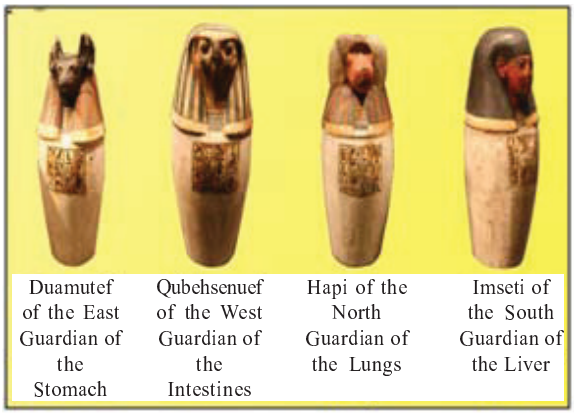


Figure 2 Canopic jars[6]

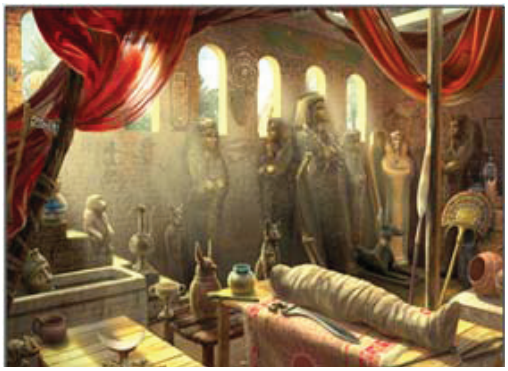


Figure 3 Embalming process inside anibu[7]

Arsenic Embalming

From the Civil War until about 1910, arsenic was the main ingredient in embalming fluids along with creosote or mercury. Much less complicated and less time consuming than the Egyptian method and the basis for modern embalming, arsenic mixed with water was injected through the arterial system. Arsenic embalming began as a sanitary practice and a practical means to preserve the body until burial or for transport. Although effective, arsenic is toxic and persistent, and elemental arsenic never degrades into harmless by-products. Consequently in the early 1900s, arsenic use was banned from embalming due to the concern for health of embalming practitioners and interference with autopsies after embalming had occurred.[1,8]

Modern Embalming and its development

Embalming by arterial injection was developed in the first half of the 17th century by the noted English physiologist William Harvey. The first attempts to inject the vascular system were made by Alessandro Giliani of Persiceto.[1]Jean Gannal (1791-1882) became the first to

offer embalming to the French general public. The American Civil War (1861-1865)was the turning point in breaking down public resistance to "mutilating" the body and in establishing arterial embalming as a common practice in the United States where embalmers experimented with a wide combination of arsenic, mercury, creosote, turpentine and various forms of alcohol.[3]

Religious practices

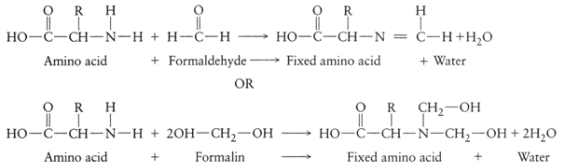
There is a difference of opinion amongst different faiths as to the permissibility of embalming. Most branches of the Christian faith, members of Iglesia ni Cristogenerally allow embalming whereas some Neopagans, members of the Bahai Faith, Zoroastrians, Jews and Muslims discourage embalming, believing it to be unnatural to disrupt the physical recycling of the body to the Earth owing to the false notion that embalmed bodies do not decompose.[1]

Embalming protocols

Embalming fluid contains a mixture of formaldehyde, glutaraldehyde, methanol and other solvents. The formaldehyde content ranges from 5-35 % and the ethanol content may range from 9-56 %. Other agents used are sodium citrate (about 1kg), NaCl (about 0.75kg), glycerine (about ½ litre) and Na-Borate (about ½ litre).[9] The formaldehyde content in arterial fluids is measured by index which is the total percentage of formaldehyde gas in the fluid. Fluids with an index of 5-15 are considered to be low firming fluids; 16-24 produces medium firming and 25 and above highly firms the tissue. It is often necessary to perform embalming within 6-12 hours of death in summer and 24-48 hours in winter.[4] The embalmer must inject about 1 gallon of fluid for every 50 pounds of body weight, i.e., a 70kg body would require fluid equivalent to 10 litres. A typical gallon of fluid is made up of 1 bottle of arterial fluid, 1 bottle of co-injection fluid, 1 bottle of water corrective and enough water to complete the gallon which changes depending on the condition of the body.[1] Formaldehyde is extremely toxic and IARC (*International Agency for Research on Cancer)*classifies it as a Class I carcinogen. OSHA (*Occupational Safety and Health Administration*) regulates its use in funeral homes.[10,11]

How it works

Embalming fluid acts to fix (denature) cellular proteins, which no longer acts as a nutrient source for bacteria and also kills the bacteria. Diffusion occurs into the cells and tissues for preservation at the capillary level. Formaldehyde fixes tissue or cells by irreversibly connecting a primary amine group in a protein molecule with nearby nitrogen in a protein or DNA molecule through a -CH_2- linkage called a Schiff base. Via colour changes, the end result also creates the simulation of the appearance of blood flowing under the skin.[1,12]



Five steps of embalming procedure

When death occurs and authorization is granted by the family, doctor, and/or by the medical examiner, the embalmer is called upon to carry out the process which involves mainly five steps:[13,14,15]

1. **Pre-embalming:** An embalming report is filled out that logs all personal belongings, discolourations and injury details and documents the procedures and chemicals used during embalming; followed by loosening of Rigor Mortis, removal of bandages, catheter/cannula, shaving of face etc.

2. **Feature setting:** Resetting of facial features and the body itself is done before arterial embalming. The eyes are either clogged with bit of cotton or fitted with eye-caps to hide shrunken eyeballs. The mouth is closed either by tying the jaw together with a piece of suture string or by a special injector gun. A small amount of stay cream is also used on the mouth to avoid dehydration and hold the lips in place.

3. **Arterial embalming:** In arterial embalming, the fluid composed of preservatives, germicides, anticoagulants, dyes and perfume is pushed into an artery while the blood is drained from a nearby vein or from the heart **(Table 1).** The right side of the body near the collarbone is preferred to access the right common carotid artery[14] and the right internal jugular vein. Commonly a solitary location known as a single-point injection or single-pointer is used whereas in cases of poor circulation additional injection points (axillary, brachial or femoral arteries[14], with occasional ulnar, radial and tibial vessels) are used. An injection utilizing both the left and right carotids is specifically referred to as a *restricted cervical injection (RCI),*

while draining from a different site to injection is referred to as a *split/cut injection.*

The embalming machine regulates pressure (the force of the fluid) and rate of flow (speed of the fluid) to create the optimum rate of injection for the body either with continuous or alternating pressure in sync with period of drainage. Drainage can also be achieved by keeping the vein open using angle forceps which allows clots and blockages to flush out more easily. Pre-injection chemicals used break up clots and condition vessels while co-injection chemicals restore dehydrated tissues, fight oedema (too much fluid in the tissues), and correct hard water. Dyes used in arterial fluids, back flow of the arterial fluid and firming of the tissues provide hint to the extent of penetration.

4. **Cavity embalming:** Arterial fluids mainly treat the skin, muscles and organ parenchyma, as such organ contents such as urine, bile, etc. begin to decompose. Gases and bacteria pent up, causing distension and purgation out of the external orifices. As such cavity embalming becomes a necessity.

   Fluids of the internal organs are aspirated by the use of a trocar[15]connected to a device that creates suction(electric aspirator or water powered aspirator (hydro-aspirator). It is inserted near the belly button (two inches superior and two inches to the right) and gases and fluids are withdrawn before 2 bottles of full strength fluid are injected and subsequently drained to treat the entire thoracic and abdominal cavities. Post autopsy the organs are dissected out and incinerated or are treated with chemicals, stuffed back and the hole is closed with trocar button. Cavity fluids are slightly more acidic than arterial fluids and hence produce firmer tissues in a faster time **(Table 2).**

5. **Post embalming:** The body and hair are washed and then thoroughly dried and combed, restorations are done, makeup is applied and fingernails are trimmed by a professional. The body is dressed in an outfit and placed into the casket for display. Some embalmers utilize hypodermic bleaching agents, such as phenol based cauterants, during injection to lighten discoloration and allow for easier cosmetizing or apply methylated spirit to negate foul smell.

Other methods

Hypodermic embalming is a supplemental method for injection of embalming chemicals into tissue with a hypodermic needle and syringe, which is used as required to treat areas where arterial fluid has not been successfully distributed during the main arterial injection.[1]

Surface embalming utilises embalming chemicals to preserve and restore areas directly on the skin's surface and other superficial areas of damage such as from accident, decomposition, cancerous growth or skin donation.[1]

Table 1 Composition of embalming fluids[16]

Ingredients	Proportion
Formalin *(preservative)*	1.5 litres
Sodium borate *(buffer)*	600 g
Sodium citrate *(anticoagulant)*	900 g
Glycerine *(wetting agent)*	600 g
Sodium chloride *(controls pH)*	800 g
Eosin 1% *(cosmetic)*	30 ml
Soluble wintergreen *(perfume)*	90 ml
Water *(medium)*	Up to 10 litres

Table 2 Composition of cavity embalming fluid[16]

Ingredients	Proportion
Formalin	60%
Methanol *(preservative)*	25%
Liquefied phenol *(germicide)*	10%
Sodium lauryl sulphate	1%
Mercuric chloride	1%
Eucalyptus oil	1%

Types of injectors

Various types of injectors are used in modern embalming to carry out the process in a more effective way. Some commonly used are:[16]

1. **Hand/ foot pump**
2. **Stirrup pump**
3. **Bulb syringe**
4. **Gravity injector**: It is the simplest, safest and slowest method.
5. **Motorized injectors:** About 10 liters of arterial fluid is injected in 30 minutes and pressure maintained is about 2kg/sq cm.[16]

Methods of injection and drainage

1. **Continuous injection and drainage:** Both arterial injection and venous drainage are done

simultaneously. The process saves time but is least satisfactory.

2. **Continuous injection with disrupted drainage:** Arterial flow is maintained continuously but venous drainage is done discontinuously when pressure increases.
3. **Alternate injection and drainage:** The process of injection and drainage is done alternately.
4. **Discontinuous injection and drainage:** It is considered the best method. It consists of injection at 2 hours interval for 2-3 times followed by drainage little before and after injection.[16]

Legal formalities

Embalming in India is performed by medical experts/ doctors only for academic, transportation, repatriation, display or any other legal purpose. Legal requirements over practice of embalming vary geographically; while some regions or countries have no specific requirements at all. The Federal Trade Commission in America as part of "The Funeral Rule" has spelled out several important guidelines to govern funeral directors and embalmers in the practice of embalming. According to "The Funeral Rule":[1]

i. **Law of the land:** The Funeral Director must be forthright in disclosing the fact that embalming is not a legal requirement as Federal Law does not require embalming under any circumstances and unusual circumstances may crop up due to local or state guidelines and must be for a particular reason.
ii. **Consent:** The family of the deceased or the person planning the funeral has to give consent for the body to be embalmed which must be expressly stated and cannot be simply implied;as merely agreeing to the funeral does not mean expressed consent to embalming.[1,4,17]
iii. **Notifiable diseases and conditions:** The chain of custodians of the deceased has to be notified about the infectious status at every level.
iv. **Fees, expenses and receipts:** According to these legal guidelines, a funeral director may charge the grieving family a fee for embalming and state clearly the legal requirement on an itemized bill only when authorities or the law (either state or local) permits it for some special reason.

REFERENCES

1. Embalming. [Online]. [cited 2015 May 5]; Available from:URL:http://en.wikipedia.org/wiki/Embalming
2. Tutankhamun's mummy. [Online]. [cited2015 May 7]; Available from: URL:http://en.wikipedia.org/wiki/Tutankhamun%27s_mummy
3. American Civil War. [Online]. [cited 2015 May 11]; Available from: URL:http://www.britannica.com/EBchecked/topic/19407/American-Civil-War
4. Vij K. Embalming. Textbook of forensic medicine and toxicology.5thed.Kundli (Haryana): Elsevier; 2011. p. 26-27.
5. Storage of organs in canopic jars. [Online].[cited 2015 May 12]; Available from: URL:http://www.britannica.com/topic/embalming
6. Canopic jars for organ storage in Egyptian embalming. [Online]. [cited 2015 May 15]; Available from:URL:http://emhotep.net/2011/06/28/egypt-in-the-news/mumab-a-modern-day-ancient-egyptian-mummy-and-what-he-has-taught-us-so-far/
7. Egyptian embalming process. [Online]. [cited 2015 May 15]; Available from: URL:http://hiddenchronicles.wikia.com/wiki/Egyptian_Mask
8. Konefes JL, McGee MK. Is Arsenic an Aphrodisiac? Old Cemeteries, Arsenic, and Health Safety, Cultural Resources Management. Cullen; 1996;19IO:15-18.
9. Nandy A. Preservation of dead bodies. Principles of forensic medicine including toxicology. 3rded. Howrah (Kolkata): New Central Book Agency(P) Ltd; 2010.p. 282-84.
10. International Agency for Research on Cancer. [Online]. [cited 2015 May 12]; Available from: URL:http://en.wikipedia.org/wiki/International_Agency_for_Research_on_Cancer (IARC)
11. Usage of Formaldehyde in Funeral Homes. [Online]. [cited 2015 May 12]; Available from: URL:https://www.osha.gov/OshDoc/data_General_Facts/formaldehyde-factsheet.pdf
12. Mayer RG, Taylor J. Embalming: History, Theory and Practice. 4th ed. Tata McGraw Hill; 2005.
13. The 5 stages of Embalming. [Online]. [cited 2015 May 15]; Available from: URL:http://listverse.com/2007/11/08/the-5-stages-of-embalming
14. O'Sullivan E, Mitchell BS. An improved composition for embalming fluid to preserve cadavers for anatomy teaching in the United Kingdom. J Anat 1993 Apr;182(Pt 2):295–97.
15. Karmakar RN, editor.Process of preservation of dead bodies.J.B.Mukherjee's Forensic medicine and toxicology. 4th ed. Kolkata: Academic Publisher; 2011. p. 274.
16. Reddy KSN, Murthy OP. Embalming. The essentials of forensic medicine and toxicology. 33rded. Hyderabad: K. Suguna Devi;2014. p.173-75.
17. Yadav M. Emerging Trends Related to Consent and Medical Practice. Int J of Health Research and Medico Legal Practice 2015 Jan;1(1):3-9.