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Review Article

Body Preservation Techniques - since Ancient Era to Modern Era

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ABSTRACT

Body preservation techniques are applicable since past because of most common cause religious motive. Bog watery environments are used as a natural preservation method because it inhibits bacterial growth.

We all are well known by famous mummies from ancient egypt, which are made by both the help of natural preservatives and chemicals and put in museums of this era in many cities since a long time and are well preserved, no putrefaction, no foul smell till now. In history before the introduction of chemicals (most frequently formalin), a technique was used to preserve anatomical specimens by injecting hot wax into anatomical specimens. Until the discovery of blood circulation, anatomical dissection without body preservation persisted. Initially in history.

In educational purpose we also preserve the body since the past by various methods. Nowadays in medical terms this technique is known as embalming. Now a days we preserve anatomical specimens by injecting most frequently a chemical formalin and place them in a glass jar filled by a dilute solution of formalin.

KEYWORDS

• Body preservation • Mummies • Embalming

INTRODUCTION

Body preservation techniques have been applicable since the past, mummies are a well known term for this, and all of us aware form this word.

In education purpose we also preserve the body since past now a days in medical term this technique is known as embalming. (The preservation of cadavers to avoid put refaction is known as embalming).

In English, embalming means "to put on balm," which refers to the use of spices and fragrances to prevent cadavers from decomposing. The art and methods of embalming originated in ancient Egypt approximately 5000 years ago.

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Review of literature: The core of Egyptian religion was the belief in physical resurrection and immortality; they held that a person would be resurrected once their soul, shadow, heart, and body were all reunited. Thus, they preserved dead bodies and called them mummies. In a cemetery in Guanajuato, northwest of Mexico City, mummies were also found. Graves were dug up between 1896 and 1958 because relatives were unable to pay the grave tax.

The arid climate and soil conditions caused bodies to naturally dry out before they could decompose

Mummies: figure 1 - The **natural production of mummies** (from ancient Egypt), in Greenland it was caused by freezing temperatures.

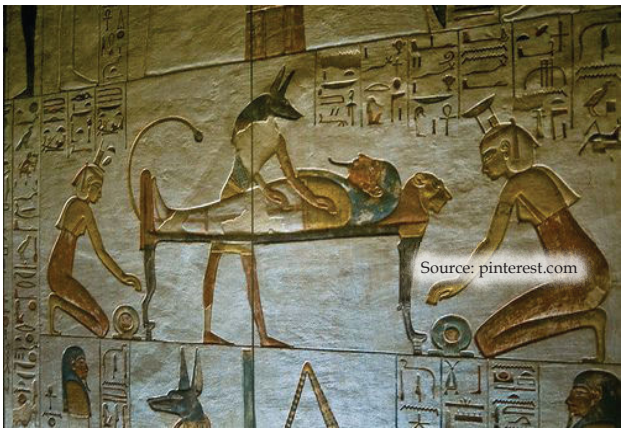


Figure 1: Anubis tending a mummy of the king, Thebes, Egypt

- Bog mummies were discovered in chilly, wet peat bogs in Ireland.
- (A bog's watery environment inhibits bacterial growth.) Natural preservation methods:
- *Freezing:* The ice and snow-capped mountains preserve bodies for centuries.
- *Dry cold:* Natural mummies were created by a dry, freezing air current over the corpses in a Swiss mortuary.
- *Dry heat:* Mummies were naturally formed in warm, arid regions of southwestern America, Egypt, and Peru.
- *Soil type:* If the soil is heavily impregnated with salts like copper or aluminum, the bodies are preserved in excellent condition.

Bog water

Three eras can be distinguished in the history of the embalming process:

- For religious purposes, the first period anatomists Egyptian period, 3200 BC–650 AD.
- The second period anatomists studied human anatomy from 650 AD to 1861.
- *Third period (1861 to the present):* primarily for cadaveric organ transplantation, human dissection for medical students, and funerals.

Egyptians of the first period had a religious motive. Because of the belief in eternal life, embalming techniques were kept secret and only accessible to royal dynasties. Egyptian mummies were prepared with Bitumen

Moreover, natron was employed as a desiccating and defatting agent. Mummification starts in the exposed areas, like the hands, feet, and face, and progresses to the trunk. The entire mummification process, from death to burial, takes about 70 days (about 2 and a half months).

According to an Egyptian Papyrus (1550 BC). The body was disemboweled, cleaned, and washed from the first to the sixteenth day. From the sixteenth to the thirty-sixth day, the body was kept under natron and its cavities were filled with myrrh powder and other fragrant resins and perfumes. Day 36–68: bandaging and seasoning. On days 68 and 70, the body was placed in a casket.



Figure 2 & 3: Canopic jars stored the cured entrails for all eternity

The Egyptians separated and stored the putrefiable organs (intestine, stomach, brain, etc.) in canopic jars (figure 2,3) because they were aware of the fact that the Canopic jar lids were made from the heads of various animals. Babon's or ape's head-lungs; Jackal's head-stomach; and human head-liver. Hawk's intestine-head Anubis caring for the king's mummy in Thebes, Egypt the cured entrails were preserved for all eternity in canopic jars.

The goal of the second period anatomists (650–1861) was to learn about human anatomy. Due to the lack of a cadaver preservation technique, dissection was frequently performed during the colder months of the year. As a result, dissection was typically completed in four to five days.

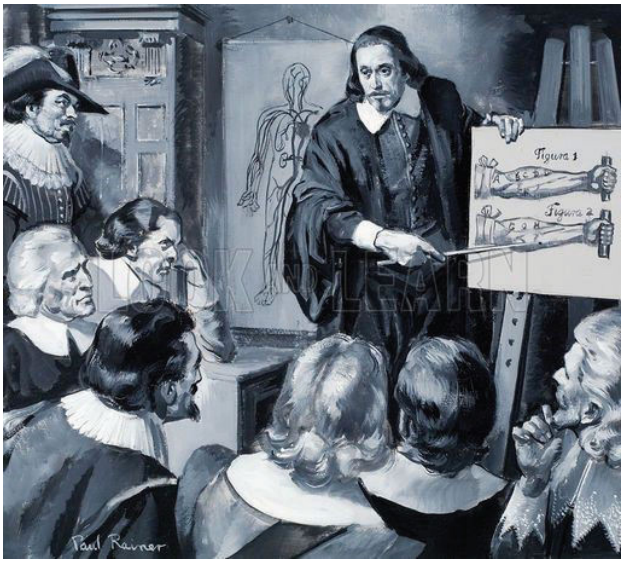


Figure 4: William Harvey (1578-1657)

Until the discovery of blood circulation, anatomical dissection without body preservation persisted. The English physiologist ***William Harvey***[1] (1578–1657) (figure 4), made the discovery that blood circulates. He authored a book on the anatomical analysis of animal blood and heart motion. It served as the foundation for all current studies on the heart and blood vessels. Following Harvey's discovery of circulation, the mortuary practice of embalming by arterial injection emerged. The connection between the arterial and venous systems was the sole weakness in Harvey's theory of circulation.

The discovery of capillaries by Italian anatomist ***Marcello Malpighi***[2] (1628-1694) in 1661 served as the catalyst for this connection. Preparing specimens, a new art form, first appeared in the late 1600s. Anatomists started gathering and displaying bodies and body parts. Viewers were awed by these authentic specimens.

The preservation methods of three Dutch friends Stephen Blanchard, Jan Swammerdam, and Frederik Ruysch (figure 5) were well known.

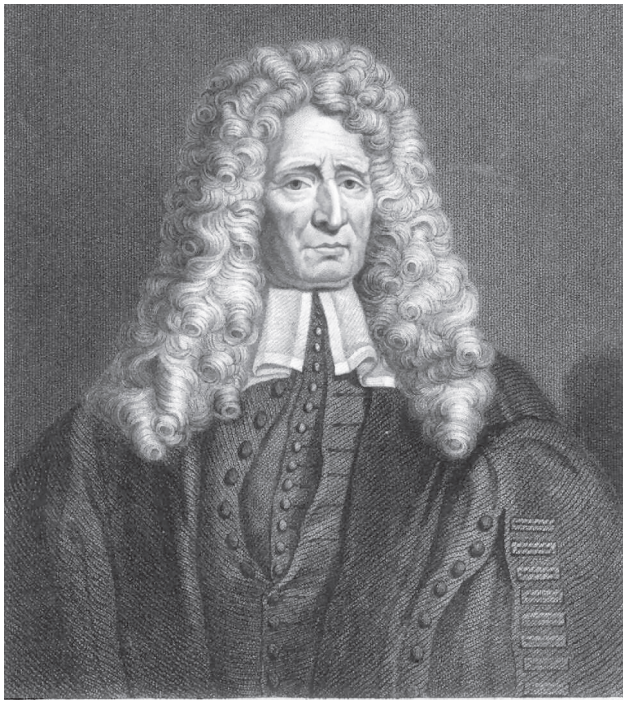


Figure 5: Frederik Ruysch (1638-1731)

Dutch anatomist Frederik Ruysch[3] (1638–1731) was a pioneer in organ preservation techniques, had his own museum of curiosities, and made dioramas out of body parts that featured dramatic fetal skeletons. Swammerdam, Jan[4] (1637-1680), He created a brand-new technique for injecting hot wax into anatomical specimens to preserve them. Additionally, he discovered that: Human ovaries contain eggs; lymphatic vessels have valves; penile erection is caused by a blood influx; and muscles do not expand when contracted. He outlined the uterine anatomy and learned about the nature of hernias. He studied the heart, lungs, and muscles using plethysmography.

Blanchard, Stephen[5] (1650–1720) "A New Anatomy with a concise direction for dissection of the human body with a New Method of Embalming" is the title of the book he published. It included multiple instruments and embalming method diagrams. He forced water from his mouth to his anus to wash his intestinal tract. He employed turpentine and

wine spirits as preservatives.

French doctor Luise Thomas-jerome Auzoux[6] (figure 6): Because wax models were not easily accessible and human cadavers. Auzoux found that cadavers deteriorated quickly, so he found it challenging to study anatomy.Thus, he enhanced and popularized papier mache models of anatomy.



Figure 6: Luise Thomas Jerome Auzoux (1797 - 1880)

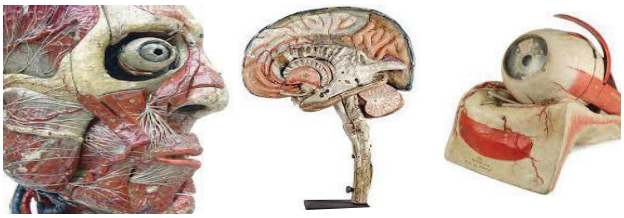


Figure 7: Wax anatomical models

Prior to papier - mache models, wax anatomical models (figure 7) were frequently utilized. Despite being beautiful pieces of art, they had a lot of flaws. The creation process was very costly and time-consuming. These were effective only for illustrative purposes, but dissection could not be replaced. Due to their affordability and ease of production, papier-mache models provided a useful substitute for wax models. Auzoux models were well-liked for teaching anatomy because of their detachable sections, which allowed for dissection experience.

Jean Niclas Gannal (1791-1852) (figure 8) was a French chemist who improved embalming techniques by injecting alkali salts (copper, mercury, and alum) and acids (acetic-arsenous-nitric-hydrochloride) into carotid arteries. He was indirectly responsible for the first law that forbade the use of arsenic in embalming solutions. The U.S. Civil War was significant because it broke down public opposition to body mutilation and established arterial embalming as a widespread practice in the United States. During the Civil War, embalming was done using a variety of chemicals and techniques. Arsenicals, zinc chloride, mercury dichloride, alumina salts, and a variety of acids and alkalis are among the chemicals used.



Figure 8: Jean Niclas Gannal (1791-1852)

Dr. Holmes and Henry Cattell were the Civil War's embalming surgeons. Known as the founder of modern embalming, Dr. Thomas Holmes (1817–1900) preserved roughly 4,000 cadavers.

The bodies of Abraham Lincoln's son Willie and Lincoln himself were embalmed by Henry Cattell. Dr. Baillie (1761-1823) was a Hunter brother's nephew. He used a shorter-term preservation technique. To wash the stomach and tie the anorectic area, turpentine and lavender oils were combined with vermillion dye. The body cavities were then filled with camphorated wine spirits.

The body's skin was placed on a bed of deep plaster after being rubbed with lavender or rosemary. Pure alcohol was promoted by

Baron Leopold Curvier as a preservative.

Third period anatomists - Zinc chloride was used as a preservative by Dr. J.P. Sucquet. Born in 1945, Gunther von Hagen[7] (figure 9): an anatomist from Germany. The plastination process was invented by him. In 1977, he began to develop the plastination process. He established the Heidelberg plastination Institute in 1993. In anatomy, plastination is a method used to preserve bodies or body parts. Plastic is used in place of water and fat in this process, preventing the specimen from rotting or smelling and even preserving most of its original characteristics.



Figure 9: Gunther von Hagen (1945, Age 80 year)

Formalin's introduction: A new era in the study of sectional anatomy began with the introduction of formalin as a tissue-hardening fluid.

Dimitrie D[8]. Gerota, a Romanian surgeon and anatomist, first used it in 1895. He sectioned and froze the body after using a 5% aqueous solution of formalin.

Terry created exceptional sections in 1900 by injecting a solution with equal parts 95% alcohol and 50% formalin without freezing, and then thoroughly decalcifying with 10% HCl for optimal effects.

Jackson used a 50% aqueous formalin solution without freezing in 1901.

In 1903, German gynecologist Hugo Sellheim used formalin-hardened bodies to create sections of female pelvises, and his illustrations were published in a large folio.

Potter published "Topography of the Thorax and Abdomen" in 1905, using Jackson's method.

ARTIFICIAL PRESERVATION METHODS

1. **Simple Heat:** On the island of Sicily, a mixture of slaked lime was used to desiccate the body. The bodies in the catacombs were dehydrated by being kept in chambers for eight months, after which they were removed and cleaned in vinegar before being exposed to the outside air.
2. **Chemical Powders:** Sawdust combined with zinc sulfate or other preservative powders was used to cover the cadavers.

Guanche technique: Immersion and evisceration

3. Similar to the Egyptians, the Guanche employed techniques that involved filling the cavity with vegetable powders and salt after removing the viscera.
4. During 650–1830 AD, evisceration, local incision, and immersion were practised in Europe, particularly in France.
5. Easy immersion: Pickled corpses in vinegar, wine, and more potent liquors.
   - Alexander the Great brought a container of honey back to Macedonia from Babylon.
   - In a cask of brandy, the British admiral Lord Nelson's body was brought back to England from Trafalgar.
6. The Hunter brothers practised arterial injection and evisceration.
7. Gabriel Clauderus, cavitation injection and immersion
8. Arterial injection: Gannal and Sucquet practiced injecting preserving fluid into the arteries.
9. Morgues and hospitals use refrigeration.
10. Plastination: This special technique keeps tissue in a lifelike condition. Developed by agermananatmist Gunther von Hagen.

Plastination - formalin is introduced in body through arterial system->after 3-4 hrs,

it destroy all bacteria->body no longer decay->acetone bath at -25 degree (many times) for dehydration & defatting (3-4months) ->forced vacuum impregnation (6-8 wks) - in liquid silicon & subjected to vacuum->hardened by special gases.

Now a days – preservative methods for bodies - **Embalming**

1. for educational purpose and

2. transportation of dead body by flight or by other means for a long distance by injecting in the dead body A chemical groups make up the embalming fluid.

- Modern Embalming The needs of forensic science in order to detect crime led to the abandonment of these metallic poisons and slowly the arterial injection method took over, William Harvey (1578-1657) Demonstrated the circulation of blood by injecting colored solution into the arteries, Embalming through arteries was first practiced in England by William Hunter (1718-1783), an eminent anatomist and surgeon from Scotland.He was originally injected a solution-inventor of injection technique in artery.

Embalming Fluids Chemicals

The following are the main ingredients of embalming solution:

A. Disinfectants

B. Preservatives

C. Repair agents

• **The following chemical groups make up the embalming fluid:**

1. Preservatives

2. Germicides

3. Buffers

4. Agents for wetting

5. Anticoagulants

6. Colors

7. Diluents /Vehicles

8. Fragrances

Preservatives: By deactivating saprophytic bacteria and changing lysosomal enzymes, they stop putrefaction and autolysis.

Among them are methyl alcohol and formaldehyde, which are the most widely used.

• Carbolic acid and phenol - **Germicides**: They contain phenol and phenolic derivatives; they also kill microorganisms.

Glutaraldehyde and Zephiran chloride also kill microorganisms

Turpentine oil and a few thymol crystals are examples of **fungicides**.

Buffers: • The medium's pH affects the chemicals' stability in the embalming fluids. Thus, buffers are employed. Magnesium carbonate, sodium carbonate, sodium bicarbonate, and sodium borate (Borax).

• **Wetting agents:** They help the embalming fluids penetrate and distribute into the tissues by reducing the high surface tension of water. They keep muscles supple and stop them from drying out.

These consist of: • Glycerin (the most widely used), Glycols. Sodium lauryl sulphate and sorbitol.

Anticoagulants: Anticoagulants are used to keep blood in a liquid state because clotting is the primary obstacle during the embalming process.

• It makes it easier to distribute arterial fluids and remove blood.

• They include - Sodium citrate or sodium oxalate

Dyes: These include eosin (tetra Bromo fluoresceine), Ponceau, erythrosine, amaranth, acid fuchsin, toluidine red, and rhodamine. They create an internal cosmetic effect that closely mimics the tissues' natural coloring.

Water is utilized as a **diluent** and makes up approximately 90% of all embalming fluids. • **Fragrances:** • Serve as a disguise. They change an offensive smell into a more agreeable one.

These agents include clove oil, cinnamon oil, and wintergreen oil (methyl salicylate).

• Peppermint oil (menthol)

Age, sex, the body's condition (autopsied or not), the weather, and the type of embalming (funeral or anatomical) are the factors considered when choosing and preparing an embalming fluid.

The following fluids are typically made during the embalming process:

A. Arterial fluid

B. Cavity fluid

C. Pre-injection fluid

Arterial fluid is injected into the body's vascular system(mostly in Femoral or carotid arteries); its dilution varies depending on the type of body, including normal, dehydrated, edematous, obese, refrigerated, and long-dead bodies. • One liter of arterial fluid for obese individuals

arterial fluid - composition

Formalin, is 10.0%

Methanol content: 55.0%

The buffer contains 15.0 grams of sodium borate.

Sodium citrate, an anticoagulant, 15.0%

Wetting agent – Glycerin 15.0%

The germicide phenol 5.0 percent%

The vehicle's water content is 10.0%

Fungicide: a few crystals of thymol

1% dye Eosin 5.0 milliliters

Fragrance: 10.0 ml of Wintergreen Oil

Note: A fatty body should have less glycerin

In hotter nations, formalin should be doubled.

Arterial fluid in individuals who are thin: **composition**

The amount of formalin by 10.0%

The methanol content was 55.0%.

The amount of sodium borate was 15.0 grams.

The amount of sodium citrate was 15.0 grams.

Glycerin 20%

Phenol 5.0%

Water consumption: 10.0%

Thymol 1%

The amount of Eosin 5.0 ml

Wintergreen oil (10.0 milliliters)

The strength of formalin is higher in:

Autopsied, Chilled, Diseased, Burned, Decomposing, and long-dead remains.

• **Cavity fluid:**

• It is administered hypodermically into parts of the body that have not received arterial fluid, as well as into the thoracic, abdominal, and pelvic cavities using a trocar.

• It is also applied over the surface lesions and as a surface pack.

• A trocar is used to inject about 2 liters of cavity fluid into an average body.

• The suggested composition is:

• 60.0% formalin

The percentages of methanol and glycerin are 25.0% and 2.5%, respectively.

The phenol content was 10.0%.

One percent mercuric chloride and one percent lavender.

Pre-injection fluid: The arterial system contracts during death, forcing more blood into the capillary bed and venous system.

According to estimates, capillaries contain 85% of the blood after death, followed by veins with 10% and arteries with 5%.

• The body receives an injection of pre-injection fluid before to arterial fluid.

Anticoagulants and buffers make up most of the pre-injection fluid, which is only used on Un autopsied bodies and is not frequently employed during embalming processes.

• Before injecting the arterial fluid, 4 to 5 liters of solution should be administered, and there should be a 30-minute waiting time.

• For this, a 2% arterial solution is advised.

Quantity of fluid needed: • Age, body weight, obesity, moisture content (dehydration or non-dehydration), time between death and preparation, time between preparation and disposal of refrigerated bodies, bodies with signs of decomposition, and bodies with oedema are factors that affect the strength and amount of arterial fluid needed for an effective embalming of a body.

• The vascular system of an average body contains 6–7 liters of blood.

Typically, to ensure successful embalming, the volume of arterial fluid injected should match the deceased's blood volume.

An average adult weighing 65–70 kg requires about 10 liters of arterial fluid. which encompass spills as well.

The drained amount is not included; the entire injection solution volume of 15 to 20 liters must be prepared.

The fluids listed below are utilized in anatomy dissection labs:

Paint mixture used to maintain the moisture content of dissections

Glycerin 75.0%

Alcohol content: 10.0%

Phenol 5%

Water 10%

Add a few thymol crystals to the teepol.

Tank fluid (immersion)

Formalin: 15.0%

Glycerin (20.0%)

5.0% of phenol

60.0% of water

Cloth fluid to keep isolated dissected portions and the area being dissected from drying out

5.0% of formalin

50.0% glycerin

5% Phenol

40% Water

Add a few thymol crystals to the teepol. Nervous tissue fluid

• *Formalin 10.0%* - Avoid using fluids that contain glycerine.

CONCLUSION

Body preservation has been needed since the past either for religious or for educational purpose, with advancing era, different newer chemicals or preservative have emerged.

Embalming is a scientific treatment of a dead body ensuring that it is free from possible infection to the living.

Conflict of interest: none

Science museum collection[9]

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