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Embalming: An art of preserving human body

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We can't deny the fact that medical students never forget their experiences in Anatomy dissection classes, the peculiar smell of formalin that sticks to your apron and first encounter with the cadaver remains in your memory for ever. I still remember the day entering the dissection room for the first time. I was excited but an unknown fear was there because I never saw a dead body before. It is obvious that a medical student experiences various levels of emotional and psychological reaction in the dissection room. The most frequent reactions being the recurring visual images of cadavers then palpitation and fear of infection which they cope up with rationalization with significantly higher level of these symptoms in female[1].

Walking down through the memory lane, I still remember it was the eve of our vacation. As a matter of fact we (first year students) were excited to have time out from our hectic schedule. Meanwhile, some of the students were discussing about the embalming. My very first reaction was - What's that? Subsequently, I decided to get the answer but failed to understand it clearly until I did the actual procedure.

During our dissection classes, I never thought regarding the preparation of the cadavers. To tell the truth; never bothered to go in detail. Nevertheless I knew that they were kept in formalin but why? How? How long? I couldn't find all the answer because the information was also lacking in the standard textbooks.

Experiencing embalming

It was in the early month of my second year that I got an opportunity to witness the embalming as many new dead bodies were bought for my juniors and the department was busy with the preparation of its preservation - fortunately some of us were lucky to be able to perform it by ourselves. It was a year back that I overcome my fear and apprehension but this time I was excited to learn new things that very few medical students have witnessed.

When we were informed about ongoing embalming we rushed towards the dissection room and as soon as I entered something happened to my olfactory system. As I inhaled the room air, the molecules in it got dissolved and recognized by G protein coupled receptors in my nasal mucosa and got activated. This activated G proteins, activated adenylyl cyclase, which converted ATP into cAMP which acted as a second messenger which went on to activate and opened up ligand-gated sodium channels, depolarizing the sensory neuron. This in turn generated an action potential that got passed onto the mitral cells (in the olfactory bulb) with glutamate as a neurotransmitter. A signal was sent to the limbic system of my brain through olfactory nerve and then I could figure out that it was the pungent smell of formalin.

The once familiar room was a horrifying scene, with corpse lying still, insensible in a pile. A peculiar smell dispersed all around the room. The lab attendants with mask, gloves and safety coats entered the room and started washing the corpses and then shaving head region and finished up with water cleaning. Generally in our Nepalese society, we are not accustomed to such activities; therefore I was astonished, horrified and excited at the same time and was wondering how they might have felt when they did it for the first time.

Regarding our task we were given a brief introduction on procedure and precaution for our own safety before it was started. We helped lab boys to carry the cadavers to the embalming table and did the embalming according to the instruction.

1. We put on our gloves and prepared the embalming solution as follows (for three bodies):
   I. Embalming chemicals
      a. Phenol – 6gm
      b. Borax – 45 gm
      c. Sodium Citrate – 45 gm

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II. a), b) and c) were boiled to dissolve and then were added to the mixture of liquids containing:
    d. Formalin – 5 Litre
    e. Methanol – 2.5 Litre
    f. Glycerin – 6 liter
III. Water was added in the solution containing I & II to make total solution of 12 litres, which was the embalming solution.
IV. Then embalming solution was kept in a jar 4 meter above the ground to facilitate the passage of the fluid due to gravity during infusion.

2. Then cotton pads were inserted in the nose, ears and mouths of the cadavers to avoid any leakage.
3. After the cadaver was stretched to its full extension, an incision was made in the area of femoral triangle.
4. Femoral artery was identified, a trocar - a long, pointed, metal tube was inserted and embalming fluid was infused
5. With the help of syringe, the embalming fluid was injected in the abdomen, thorax, limbs, muscular part and all the other body cavities.
6. Embalming fluid was infused through the superior orbital fissure to preserve the brain maters.

After spending more than two hours, these bodies were sent to the embalming tank containing 10% formalin to make them ready to be used in the teaching and learning of Human Anatomy in the dissection room after 10 days of storage.

History of embalming

In classical antiquity, perhaps the old world culture that had developed embalming to the greatest extent was that of ancient Egypt probably before 4000 BC, and was used by them for more than 30 centuries. It was Egyptians who developed the process of mummification[2]. Embalming has been prevalent in many cultures for variety of reasons like believing that preservation of the body empowered the soul after death, which would return to the preserved corpse in Egypt to other cultures eg., Peru, where climate also favored a form of mummification. Whereas in the Netherlands embalming is not allowed except in the case of international transport of the corpse and in the case of members of the royal family, who choose individually for or against it.

The first man to embalm by injecting a prepared preservative chemical solution into the blood vessels is believed to be the Dutch anatomist Fredrik Ruysch, but his technique is unknown. In 1867, the German chemist August Wilhelm von Hofmann discovered formaldehyde, whose preservative properties were soon discovered and which became the foundation for modern methods of embalming.

In the 19th and early 20th centuries arsenic was used frequently as an embalming fluid but has since been supplanted by other more effective and less toxic chemicals. It was also because of legal concerns as people suspected of murder by arsenic poisoning could claim that the levels of poison in the deceased's body were a result of embalming post mortem rather than evidence of homicide.

Modern embalming is believed to have begun in the U.S. during the American Civil War. The essential purposes of modern embalming are preservation of the body to permit burial without unseemly haste and prevention of the spread of infection both before and after burial.

Purpose of embalming

- To temporarily preserve human remains to forestall decomposition and make it suitable for display at a funeral.
- Embalming for anatomical research and study
    - A rather different process is used when a cadaver is embalmed for dissection by medical students. The first priority is for long term preservation, not presentation.
    - In short, the procedure consists of a pre-embalming treatment with blood clot disperser, removal of blood clots, drainage of blood, and arterial embalming with an embalming machine via both carotid and femoral triangles of the body.3
    - The cadavers are always very well fixed so that they can be used for not only anatomical dissection but also research for the vascular system by vasography, kinematics of the joint and other histologic examinations.[4]

The desired properties required for successful embalming of cadavers for gross anatomy teaching include[5]:

1. Good long-term structural preservation of organs and tissues with minimal shrinkage or distortion;
2. Prevention of over-hardening, while maintaining flexibility and suppleness of internal organs;
3. Prevention of desiccation;

4. Prevention of fungal or bacterial growth and spread within a specific cadaver and to other cadavers in the dissection room;
5. Reduction of potential biohazards (spread of infection to dissection personnel and students);
6. Reduction of environmental chemical hazards (especially from formaldehyde and phenol) in order to comply with increasingly severe health and safety regulations and a new awareness of possible dangers of these chemicals in the workplace; and
7. Retention of color of tissues and organs while minimizing oxidation effects that result in 'browning'.

Modern embalming

Embalming as practiced in the funeral homes of the western world uses several steps. Modern embalming techniques are not the result of a single practitioner but rather the accumulation of many decades, even centuries, of research, trial and error and invention. A standardized version follows below but variation on techniques is very common.[6]

The actual embalming process usually involves four parts:

- **Arterial embalming** involves the injection of embalming chemicals into the blood vessels, usually via the right common carotid artery. Blood is drained from the right jugular vein. The embalming solution is injected using an embalming machine and the embalmer massages the cadaver to ensure a proper distribution of the embalming fluid. In case of poor circulation, other injection points are used.
- **Cavity embalming**, the suction of the internal fluids of the cadaver and the injection of embalming chemicals into body cavities, using an aspirator and trocar.
- **Hypodermic embalming**, the injection of embalming chemicals under the skin as needed.
- **Surface embalming**, which supplements the other methods, especially for visible, injured body parts.

Embalming chemicals

Modern embalming is not done with a single fluid. Rather various different chemicals are used to create a mixture called an arterial solution which is generated specifically for the needs of each case. Potential ingredients in an arterial solution include: [6]

- **Preservative (Arterial) chemical:** These are commonly a percentage (18%-35%) based mixture of formaldehyde, glutaraldehyde or in some cases phenol which are then diluted to gain the final index of the arterial solution. Formalin refers specifically to 40% aqueous formaldehyde and is not commonly used in funeral embalming but rather in the preservation of anatomical specimens.
- **Water conditioner:** These are designed to balance the "hardness" of water (the presence of other trace chemicals that changes the water's pH or neutrality) and to help reduce the deceased's acidity, a by-product of decomposition, as formaldehyde works best in an alkaline environment.
- **Cell conditioner:** These chemicals act to prepare cells for absorption of arterial fluid and help break up clots in the bloodstream.
- **Dyes:** These are use to restore someone's natural coloration and counter stain against conditions such as jaundice.
- **Humectants:** These are added to dehydrated and emaciated bodies to help restore tissue to a more natural and hydrated appearance.
- **Anti-oedemic chemicals:** The opposite of humectants these are designed to draw excessive oedemic fluid from a body.
- **Additional disinfectants:** For certain cases, such as tissue gas, specialist chemicals normally used topically such as Dis-Spray are added to an arterial solution.
- **Water:** Most arterial solutions are a mix of some of the preceding chemicals with tepid water. Cases done without the addition of water are referred to specifically as waterless. Waterless embalming is very effective but not economically viable for everyday cases.
- **Cavity fluid:** This is a generally a very high index formaldehyde or glutaraldehyde solution injected undiluted directly via the trocar incision into the body cavities to treat the viscera. In cases of tissue gas phenol based products are often used instead.

Specialist embalming

Decomposing bodies, trauma cases, frozen and drowned bodies, and those to be transported for long distances also require special treatment beyond that for the "normal" case.[6] The recreation of bodies and features damaged by accident or disease is commonly called restorative art and is a sub-speciality inside embalming, although all qualified embalmers have some degree of training and practice in it. It is on these cases that the benefit of embalming is startlingly apparent. Many people have unreal expectation of what a dead body should look like due to seeing many "dead" bodies on television shows

and the work of a skilled embalmer often results in the deceased looking like they have done nothing at all as the deceased appears so lifelike.

Embalming autopsy cases differs from standard embalming as the nature of the post mortem irrevocably disrupts the circulatory system with the removal of organs for examination. In these cases a six point injection is made via the two femoral arteries, axillary vessels and common carotids, with the viscera treated separately with cavity fluid in a viscera bag. In many mortuaries in the United States (such as the LA County Coroners Office) and New Zealand these necessary vessels are carefully preserved in the autopsy process while in other countries such as Australia, where embalming has been less common historically, they are routinely excised. This lead to an inability to properly embalm the deceased for the family and is a common source of conflict between governmnet pathologists and embalmers there.

Long-term preservation requires different techniques, such as using stronger preservative chemicals, multiple injection sites to ensure thorough saturation of body tissues, and -in the case of a body to be used for anatomical dissection- taking no blood drainage and doing no treatment of the internal organs.

Hazards of embalming

Johns Hopkins researchers have reported the first known case of tuberculosis (TB) transmitted from a cadaver to an embalmer[7].

Infectious HIV has been reported in the pleural fluid, pericardial fluid, and blood of such patients after storage at 2 °C for up to 16.5 days post mortem[8]. There is also reported case of HIV recovered from bone fragments, brain, bone marrow, spleen, and lymph nodes from a patient with AIDS at autopsy six days after death[9]. An accidental injury may occur during embalming. An occupational HIV infection in a nurse who was pricked by a needle that had been used on a drug addict has been reported[10]. The most frequently used fixatives and disinfectants are ethanol, formalin, and phenol. In suspension tests, 25 percent ethanol and 0.5 percent formaldehyde were shown to be effective against HIV[11].

Conclusion

Embalming, in most modern cultures, is the art of temporarily preserving human remains to forestall decomposition and make it suitable for display at a funeral on the other hand a science of preserving human body for anatomical research and study.

Most of the medical students do have little knowledge about the details of embalming. It would be useful if there were an introductory class or a single lecture especially for first year medical students which would be beneficial and also help them coping with emotional and psychological reaction in the dissection hall.

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References

1. Ziad M. Bataineh, Taghreed A. Hijazi, Marwan F. Abu Hijleh, Attitudes and reactions of Jordanian medical students to the dissecting room. Surgical and Radiologic Anatomy 2006 Aug 28 (4):416-421
2. Mayer, Robert G. Embalming: History, Theory and Practice. Appleton & Lange. 1990
3. Bradbury SA, Hoshino K. An improved embalming procedure for long-lasting preservation of the cadaver for anatomical study. Acta Anat (Basel). 1978; 101(2):97-103.
4. Ikeda A, Fujimoto K, Yoshii I, Matsumoto S, Nishitani K, Ikeda K. Arterial embalming method of the cadaver and its application to research. Kaibogaku Zasshi. 1993 Aug; 68(4):410-21.
5. Raymond Coleman, Igor Kogan, An improved low-formaldehyde embalming fluid to preserve cadavers for anatomy teaching J Anat. 1998 April; 192(Pt 3): 443-446.
6. Frederick, L.G. & Strub, Clarence. The Principles and Practice of Embalming (Fifth Edition). Professional Training Schools Inc & Robertine Frederick. 1989
7. Timothy R. Sterling, M.D., Diana S. Pope, R.N., M.S., William R. Bishai, M.D., Ph.D., Susan Harrington, M.P.H., Robyn R. Gershon, M.H.S., Dr.P.H., and Richard E. Chaisson, M.D., Transmission of Mycobacterium tuberculosis from a Cadaver to an Embalmer. NEJM 2000 342:246-248
8. Douceron H, Deforges L, Gherardi R, Sobel A, Chariot P. Long-lasting postmortem viability of human immunodeficiency virus: a potential risk in forensic medicine practice. Forensic Sci Int 1993;60:61-66.[Medline]
9. Nyberg M, Suni J, Haltia M. Isolation of human immunodeficiency virus (HIV) at autopsy one to six days postmortem. Am J Clin Pathol 1990;94:422-425.[Medline]
10. Ippolito G, Puro V, De Carli G, Italian Study Group on Occupational Risk of HIV Infection. The risk of occupational human immunodeficiency virus infection in health care workers. Arch Intern Med 1993;153:1451-1458.[Abstract]
11. Sattar SA, Springthorpe VS. Survival and disinfectant inactivation of the human immunodeficiency virus: a critical review. Rev Infect Dis 1991;13:430-437.[Medline]