International Journal of Anatomy and Research,
Int J Anat Res 2016, Vol 4(3):2531-35. ISSN 2321-4287
DOI: http://dx.doi.org/10.16965/ijar.2016.265

Original Research Article

EMBALMING FLUID - MODIFIED COMPOSITION FOR HOT AND HUMID PLACES

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ABSTRACT

Background: The human cadaver is the chief member of the department of anatomy in any medical school or a college, who draws the maximum attention, love, care and regard and so needs to be preserved well. Embalming is a well known technique for preservation of cadavers with chemicals.

Aim: It was felt that the composition of embalming fluid should vary with the climate of any place. In hot and humid weather as seen in Kanpur, Uttar Pradesh the cadavers tend to putrefy faster as compared to cold places. Hence the present work was undertaken to formulate the composition of embalming fluid for a hot and humid places like Uttar Pradesh, India.

Material and Methods: In addition to the old standard ingredients of embalming fluid viz. formalin, glycerine and carbolic acid being used in the department since past years, other antiseptic and antifungal ingredients like thymol, Potassium Nitrate, Naphthalene flakes, Boric Acid, Ammonium Bromide, sodium Citrate and plenty of Common Salt were added in the water. The embalming fluid so prepared was instilled in the body.

Result and Conclusion: The cadavers with the modified embalming fluid were better preserved, soft and long lasting than the past years. It was concluded that the composition of the embalming fluid should be modified according to the climate of the place and antifungal agents must be added in the solution in the hot and humid places.

KEY WORDS: Anatomy, Body Preservation, Cadaver, Dissection hall, Formalin Embalming fluid, Humid places.

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Access this Article online

Quick Response code

DOI: 10.16965/ijar.2016.265

Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 20 May 2016 Accepted: 15 Jul 2016
Peer Review: 20 May 2016 Published (O): 31 Jul 2016
Revised: None Published (P): 31 Jul 2016

INTRODUCTION

The human cadaver is the first teacher and the first patient of a first year MBBS student whom he examines and dissects minutely for the whole one year [1-2]. The words of gratitude for the cadaver need to be actually expressed as proper embalming and preservation as action. Preservation of cadavers has been a practice since ancient times [3-4].

Embalming is a chemical process that is used to preserve and sanitize the human body after death [5].The desired properties required for successful embalming of cadavers for gross anatomy teaching include: (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 speciûc 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 and (7) retention of colour of tissues and organs while minimising oxidation effects that result in 'browning' [6].

Most of the reports available [6-7] for the composition of embalming fluid are related to cold places which could not be used in our set up because of cost, technique, resources and relative output. This led us try and find economical and practical solution for a place with hot and humid weather.

MATERIALS AND METHODS

The work was undertaken at department of anatomy, GSVM Medical College, Kanpur, Uttar Pradesh, India. In the department, all the cadavers received were from persons who voluntarily donated their bodies to medical science. The cadavers reach the department within 24 h of death and embalming is usually done on the same day. The local temperature range experienced at the place was 19 - 45 degrees Centigrade. It was experienced that the use of conventional embalming fluid with formaline, glycerine and carbolic acid as constituent could not give desired results. Often the cadavers would dry up, harden, darken and develop moulds after 2-3 months leading to disinterest among the students and staff for further dissection. Based on the review of available literature, the embalming solution for one cadaver was constituted with the materials viz. –a)Formalin (40%)- 2lit; b) Methyl alcohol / isopropyl alcohol /Surgical Spirit- 1 litre; c) Glycerin- 1lit; d) Phenol/ Carbolic acid – 0.5lit; e) Borax /Sodium tetraborate /sodium borate / boric acid – 50 gm; f) Sodium Citrate – 50 gm; g) Thymol – 50 gm; h) Naphthalene flakes- 50 gm { d-h were boiled to dissolve in water}; sodium chloride – 500gm; potassium nitrate- 250 gm; Ammonium Bromide – 250 ml; Eosin- 5 ml added to adequate amount of water (fig. 1).

Fig. 1: Chemicals used for embalming.

The solution was made up to 12 litre with tap water for one cadaver. For larger cadaver 20litre of solution was made for embalming. Twenty cadavers received in the department in a period of 18months were embalmed with embalming fluid of above composition. The results were compared on the basis of overall experience in past when the embalming solution (12 litre) was composed of only Formaline, Glycerine, Carbolic acid in 3:2:1 ratio with tap water.

All the above chemicals were of standard grade except for the sodium chloride which was common household salt purchased from a local market. The embalming ûuid was perfused via the femoral artery using a mechanical pressure pump at 750–1000 mmHg. The cadavers were then kept submerged for a week in a stainless steel tank with 5% formaline solution with 500 ml of thymol, naphthalene and turpentine oil added to it. Then the cadavers were shifted in mortuary freezers at 4 °C, until further use.

RESULTS

The modified embalming mixture resulted in cadavers with excellent dissection properties and a dissection room that was virtually free of smell. There was very little smell of formaldehyde in the dissection room. The cadavers remained mould free and soft throughout the year. The colour of the soft tissue and muscles was also pleasant as compared to the cadavers in past 2 yrs which used to get too dry and dark within 2-3 months and develop mould and infection resulting in a peculiar bad smell in dissection hall. The low formaldehyde levels in the dissection hall in the embalming solution allowed prolonged

dissection by faculty and students without any of the common complaints associated with formaldehyde exposure such as eye-watering, or disturbances to the respiratory tract.

DISCUSSION

Embalming fluid acts to fix cellular proteins, so that they are denatured and cannot act as a nutrient source for bacteria. It also possesses bactericidal properties. Typically the embalming fluid is composed of- fixative or preservative, disinfectant, modifying agent (buffer, anticoagulant, surfactant, humectants, dyes, perfuming agent, diluent [8-9]. The most frequently used fixatives and disinfectants are ethanol, formalin, and phenol. 25 percent ethanol and 0.5 percent formaldehyde were shown to be effective against HIV [10].

Commercial Formalin is 37 percent by weight or 40 percent by volume of formaldehyde gas in water. It becomes acidic on storage due to production of formic acid. It fixes tissue or cells by irreversibly connecting a primary amine group in a protein molecule with nitrogen in a protein or DNA molecule through a -CH_2- linkage called a Schiff base. The crosslinking can cause DNA to keep cells from stopping the replication process in exposed persons which can lead to carcinoma [11]. Thus the toxic effects of exposure to formaldehyde are irritation of mucous membrane, upper respiratory tract irritation, contact dermatitis and mutatagenicity or carcinogenicity [12-13]. Besides, the higher concentration of formaline causes hardening [14]. Despite its toxic effects, formaldehyde still remains essential ingredient of composition because of its proven efficiency and consistency of results. The subject has been largely neglected and relatively few reports on embalming of cadavers for gross anatomy laboratories have appeared or addressed this issue [15-20]. Most of the reports deal with the need to reduce the concentration of the formaldehyde in embalming fluids or the use of formaldehyde substitutes. Some of the workers have used Phenoxyethanol [17] and Glutaraldehyde [21] as a good substitute but both are required in very large volume. Besides, slow fixation process and expenses make these not feasible for routine use in anatomy department. We have also attempted to reduce the amount of formaline to just half in our composition and substituted other chemicals for better preservation.

The surgical Spirit (methyl alcohol) added in the solution helps in complete dispersion of formaldehyde into the body tissues as it prevents polymerization of formaldehyde and acts as an antirefrigerant. It also coagulates the albumin and kills many organisms [15].

The Carbolic acid (Phenol C6H5OH) is a powerful germicide and fungicide due to its ability to denaturate and precipitate protein and proteinaceous products and its ability effectively to destroy the cell wall due to its lipophilic character [22].

Commercial formalin becomes acidic on storage through production of formic acid. It converts hemoglobin into methaemoglobin which is purple or black in color wherein ferrous iron is oxidized into ferric oxide; hence the embalmed body turns dark or black some days after embalming [23]. Sodium tetraborate or Borax acts as a good buffer by making the formalin slightly alkaline with a pH of 9. It renders it more stable and affords protection against mould growth and bacterial decomposition [20]. The buffered formaline needs to be freshly prepared. It works as insecticide, has been used as a mild antiseptic or bacteriostatic and was used for embalming purposes [24-25].

Glycerine is a wetting agent, miscible with water and alcohol and prevents water loss from the body and keeps it soft. It facilitates the distribution of embalming fluid through vascular bed, for optimum penetration into tissues and reduces the surface tension [23]. Its amount may be further increased, if available.

Salt has been used for centuries as a cheap and excellent preservative in food stuffs in which it typically provides environments that minimise bacterial and fungal spoilage [26-27]. Our embalming solution with salt resulted in excellent long-term preservation of cadavers as also reported in past [28].

Thymol [29] and naphthalene flakes[30] are known to be very strong antimicrobial and antifungal agents , useful for embalming purpose. Ammonium bromide (Cetrimide) is a white

powder, soluble in water and alcohol. Quarternary ammonium molecule released from ammonium bromide acts as antimicrobial agent. It is bactericidal against gram positive as well as gram negative organisms. It has variable antifungal activity and effective against some viruses [23].

Sodium Citrate acts as an anticoagulant and a buffer [9]. Potassium Nitrate acts as a preservative and antibacterial agent [31] but in case it is not available, Sodium nitrate can also be used instead of it [20]. Eosin being a dye imparts a reddish hue to tissues so vessels appear more living.

The above composition gave very good and satisfactory results for routine anatomy teaching however for special purposes like Surgical skill training and Postgraduate hands-on workshops for many surgical disciplines soft embalming with Thiel Solution has been widely appraised for the method provides high standard of preservation with natural texture and colors. The Theil solution consists of monopropylene glycol, ammonium nitrate, Potassium nitrate, Sodium Sulphite, Boric acid, Chlorocresol, formaline, ethanol, morpholene but the method is very complicated and expensive to be used as a routine for dissection hall [24]. In the present composition we have optimized the composition in view of availability, cost effectiveness and procedure.

CONCLUSION

The cadavers with the modified embalming fluid were better preserved and softer than the past years. It was concluded that the composition of the embalming fluid should be modified according to the climate of the place and antifungal agents must be added in the solution in the hot and humid places. The cadavers remained free from growth of fungus and maggots with very little care throughout the year. This is a cost effective method of embalming besides it is environmentally safer for the staff and students, who would otherwise be exposed to harmful bacteria and fungi on a regular basis during routine dissection.

ACKNOWLEDGEMENTS

The authors express their gratitude towards all donors who chose to bequeath their body to medical science.

Conflicts of Interests: None

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How to cite this article:

Suniti Raj Mishra , Jigyasa Passey, Rahul Singh, Raveena Singh, Sushobhana, Priyanka Sinha. EMBALMING FLUID - MODIFIED COMPOSITION FOR HOT AND HUMID PLACES. Int J Anat Res 2016;4(3):2531-2535. **DOI:** 10.16965/ijar.2016.265