

## Glutaraldehyde: A New Embalming Chemical Composition for Preservation of Cadavers for Innovative Surgical Procedures

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### Abstract

The main object of the present study is to provide a composition of body-preservation fluid which is effective in preventing decomposition of cadavers, maintaining a desired life-like appearance of the body which is non hazardous for dissection and environmentally safe. The primary aim of this study is to provide an edifice to the surgeons so that we can express our surgical talents for independent learning and thinking, perform psychomotor skills and exchange our views. Dissection can thus play many roles in the educational process. For funeral embalming it is very essential to introduce some coloring agents so as to enliven the dull state of death, whereas for the anatomical dissection it is important to restore or enhance a normal ante mortem appearance of the body.

It was observed that glutaraldehyde with other chemical composition of the embalming fluid was very effective in preservation of cadavers for surgical dissections, anatomic dissections for undergraduate and postgraduates, for staff working in the department of anatomy from the health and toxic hazards of formalin, by prevention of growth of bacteria, fungus and also decay and discoloration.

**Keywords:** Glutaraldehyde; Embalming; Embalming fluids; Cadaveric laboratory.

### Introduction

Embalming the word for the old English phrase to apply balm is derived from Latin with em- encapsulate and balming or balsam- any aromatic resins produced by certain trees of the mint family, in moist modern cultures, is the art and science of temporarily preserving human remains to forestall decomposition and make it suitable for display. Cadavers remain a principal teaching tool for anatomists and medical educators teaching gross anatomy.

In India there are nearly more than 300 medical colleges in different States. Most of these college the cadavers are utilized only for the undergraduate and post graduate

dissections in anatomy and very few institutions have been conducting cadaveric surgical workshops. Various studies have been conducted to replace formalin as a preservative but till date formalin has been the only choice left for preservation of cadavers for the anatomic dissections. An all India survey was conducted for the methods adopted in injection, precise quantity of the preservatives used, coloring agents and preservation of embalmed cadavers in the tanks for the dissection purpose.[1] Earlier studies revealed that by using carbolic acid there was mild to moderate growth of fungus, whereas the use of 20 gms of CuSo<sub>4</sub> showed no growth of fungus after 4 months.[2]

Studies also reveal that copper sulphate prevents the growth of algae and fungi and also acts as an insecticide[3] and extran in the tank solution which minimizes the growth of fungus and Surf in tanks where no growth of fungus is seen even after 16 weeks.[4] In our earlier studies we have replaced thymol with cetrimide which is not only cost effective method of body preservation, but it also has

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the added advantage of being environmentally safe for the students, who would otherwise be exposed to harmful bacteria and fungi on a regular basis during routine dissection.[5]

Our earlier studies for preservation of cadavers by formalin have also revealed that the cadavers well preserved free from maggots, bacteria with reduction of chemical hazards of formalin well suited for routine anatomic dissections and research.[6] Although the same are also utilized by the surgeons for various surgical cadaveric workshops, these cadavers were rigid, not supple and flexible to perform all the surgical procedures.

### Aims and Objectives

To temporary preserve human remains forestall decomposition and make it suitable for dissection or display at a funeral.

Good long term structural preservation of organs and tissues with minimal shrinkage or distortion.

To provide hands on training while performing innovative and newer surgical procedures and various surgical approaches in the cadaveric laboratories.

Prevention of over hardening.

Maintaining flexibility and suppleness of internal organs for surgical dissections.

Prevention of dessication.

Prevention of fungal or bacterial growth and spread within a specific cadaver and to other cadavers in the dissection room.

Reduction of potential biohazards.

Prevention of chemical hazards of formalin and phenol.

Life like appearance by retention of color by preventing the blackening effects on the skin.

For display at the funeral.

### Materials and Methods

This study was carried out in the department of Anatomy, Goa Medical College Bambolim Goa (India) from the year 2009. A donated cadaver was embalmed with the following composition of the embalming fluid.

Glutaraldehyde	5 litres
Water	5 litres
Methyl alcohol	2 litres
Glycerin	500 ml
Cetrimide	500 ml
Eosin	50 ml
Eucalyptus oil	25 ml

The embalming was done within 4 hours after the death. Glutaraldehyde (Glutarex 14) manufactured by 3M India Limited was activated by adding the entire contents of the activated vial which is attached to the Glutarex 14 container. The activated solution immediately changes color to fluorescent green only indicating that the activator has been added to the solution. Dip stick monitors were used to check the minimum effective concentration (1.5%) of 2% glutaraldehyde solution. A 13 litres 75 ml solution was prepared by adding the above agents and was embalmed by introducing a cannula in the common carotid artery by gravitational method.

Embalming by gravitation method which is simplest, safest with gravity bottle placed at 3-4 feet above the height of embalming table which provides a pressure of 0.6 kg/sq.cm. The maximum local temperature ranged between 19 and 36 degrees Centigrade and the humidity between 30 and 90%.

Arterial injection is forcing of fluid into an artery to reach the tissues through the arterioles and capillaries. In embalming the diffusion occurs at the capillary level so that the tissues and the cells are well preserved. It is therefore the capillaries which form the main

basis of circulation. The total surface capillary exchange in man weighing 70 kgs- is approximately 600 sq.mm with about 40-50 million capillaries of size 8x700 microns. There are several other factors besides the capillary resistance and chemical composition of the solution which determine the flow and diffusion of fluid into the tissues. These are the injection pressure osmosis, dialysis (diffusion) and gravity. In post embalming phase the fluid filled in excess in vessels will gradually subside and disappear into the tissues by the combined action of osmosis, diffusion (dialysis) and by gravity. This embalmed cadaver was then stored in tanks having capacity of 500 litres containing 10 percent formalin diluted in water. The tank was fully covered with Sintex lids.

### Observations & Results

It was observed that there is no growth of fungus over the last 4 years. The cadaver is hygienically safe, very supple, shows life like appearance, with no rigidity and hardness.

**Figure 1: Cadaver Seen in Sitting Position with His Hand Raised and Flexed at the Elbow**



**Figure 2: Cadaver is Seen in Sitting Position with Shaking His Hand Involving Smaller Joints**



There is elasticity of the skin with extreme flexibility of all the joints including metacarpophalangeal and interphalangeal joints. The cosmetic effects of embalming were better noticeable without blackening of the skin. In figure 1 cadaver in sitting position with flexion at elbow joint and in figure 2 the cadaver in sitting position shaking hands.

### Discussion

Anatomy is where students learn the basic language of medicine. Dissection is among the most profound experiences of medical school. Even though most clinicians fail to recall most anatomic details, nearly all remember their first dissection. However, it is in the dissection lab where mentors can model attentiveness to students needs while accomplishing traditional objectives in the allotted time.[7,8] The routine performance of the dissection provides students with training in spatial appreciation and orientation and also skills in handling the instruments.[9,10,11] Most of these are directly related to surgery but the

acquired skill in eye hand coordination and manual dexterity is relevant in a variety of clinical settings. Hence giving the cadavers an ante mortem appearance not only generates interest for dissection but also helps to identify the structures, its course, relation and variations which are encountered during the dissection.

Formalin, a commercial source of formaldehyde, is highly toxic to the living. It can cause watery eyes, nausea, cough, and tightness in chest, wheezing, skin rashes, allergic reactions, burning sensations in the eyes, nose and throat. Formaldehyde has been shown to cause cancer in laboratory animals and may cause cancer in humans. It is a miracle drug for the dead, hardening tissues and killing off bacteria, mites, maggots, fungus and the like and is being widely used as a preservative as well as fixative for anatomic dissections and also for histology and pathology laboratories.

*Glutaraldehyde*: Successfully used by Harries and Tank in 1908 exhibited properties that were many ways superior to formaldehyde in fixation of proteins in electron microscopy. Glutaraldehyde is 1,5-pentanedial; 1,5-pentanedione; glutaric dialdehyde, pungent colorless oily liquid marketed as Cidex, Sonacide, Sporicidin, Hospex and Omnicide used in industrial water treatment and also a chemical preservative.

It kills the cells quickly by crosslinking their proteins. It is frequently used as a disinfectant and sterilizing agent as bactericidal, sporicidal, fungicidal and viricidal against bacteria and viruses, an embalming fluid and tissue fixative, a component of leather tanning solutions and an intermediate in the production of certain sealants, resins, dyes and electric products. It is used for inactivation of bactericidal toxins to create toxoid vaccines eg. Pertussis toxoid component in the Boostrix Tdap vaccine. A solution of 10% glutaraldehyde is used in treatment of recalcitrant palmar, plantar and periungual warts[12,13] for plantar hyperhidrosis, for pitted keratolysis predisposing to hyperhidrosis[14] and oncomycosis.[15]

Glutaraldehyde is used widely as cold sterilant to disinfect a variety of heat sensitive instrument such as bronchoscopes, endoscopes and dialysis equipments, as hardener in x ray developing. Glutaraldehyde has linked with variety of health effects ranging from mild to severe including bronchial asthma, breathing difficulties, respiratory irritation and skin rashes.[16,17] Cross sectional studies have shown increased prevalence of irritant symptoms including itching of eyes with lacrimation and rhinitis.[18,19] and can also cause contact dermatitis.[20,21,22,23,24]

*Cetrimide*: It consists of Tri methyl tetra decyl ammonium bromide.

It is white free flowing powder, soluble in water and alcohol. It is bactericidal against gram positive as well as gram negative organisms. It has variable antifungal activity and effective against some viruses.

*Glycerin*: To facilitate the distribution of embalming fluid through vascular bed, for optimum penetration into tissues, is used to reduce the surface tension.

It is a clear, colorless, syrupy liquid, miscible with water and alcohol, absorbs and retains moisture and holds the formaldehyde gas.

*Eosin*: It is used to enhance the cosmetic effect of the deceased. It should impart color which closely simulates the natural living conditions.

*Eucalyptus (Perfuming Agent)*: Imparts aroma to mask the odors Cadavers may present a number of disadvantages. Their color, texture and smell are not like real life and cadavers cannot be palpated, auscultated or usefully asked to change position. Hence our desired goal is to produce life like appearance and minimize the smell adding aromatic compounds like eucalyptus.

It is well known that infectious pathogens in cadavers presenting particular risks include:

Mycobacterium Tuberculosis, Hepatitis B & C, AIDS virus/HIV, Prions-Spongiform encephalopathies such as Creutzfeldt -Jacob disease (CJD), Gerstmann-Straussler-Schinker syndrome (GSS). It is often claimed that

fixatives are effective in inactivation of these agents. Unfortunately cadavers, even though they are fixed, may still pose infection hazards to those who handle them. Safety precautions are necessary to avoid accidental disease transmission from cadavers before and during dissection.

Very few colleges have established cadaveric laboratory wherein unembalmed cadavers are preserved in deep freezers at -20 degrees for surgical cadaveric dissections. The cadavers are further kept at -4 degrees before the planned surgical workshops and are dissected at room temperatures. Since these cadavers are not embalmed and without any preservatives and fixatives the same cannot be utilized for the anatomic dissections and have to be disposed by incineration or deep burial. In view of new medical colleges mushrooming in our country there is dearth of cadavers and routine teaching has to be compromised due to shortage of cadavers.

In our present study the cadaver was free from growth of fungus and maggots during the last 4 years. Embalming with glutaraldehyde the cadaver is not stiff and hard but supple with extreme flexibility and is most suitable for surgical cadaveric workshops providing life like appearance. Since there is no blackening effects seen on the skin, it is also suitable preservative for cosmetic embalming for the funeral display. Not only is this the most cost effective method of body preservation, it also has the added advantage of being environmentally safe for the staff and students, who would otherwise be exposed to chemical hazards of formalin and harmful bacteria and fungi on a regular basis during routine dissection.

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