



SOFT-FIXED EMBALMING: OUR EXPERIENCE WITH PHENOXYETHANOL

Anatomy

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ABSTRACT

Introduction : Cadavers embalmed with conventional embalming fluid having formalin, glycerin, surgical spirit and carbolic acid often would dry up, harden, darken and develop moulds after 2-3 months so present study was an attempt to find out a new embalming fluid which will retain life-like appearance. **Aim:** To obtain cadavers with soft consistency of skin muscles organs and maintained joint mobility by using Phenoxyethanol for cadaveric surgical workshops. **Material & Methods:** A Comparative observational study was conducted at Dr S.N. Medical College & Hospital Jodhpur. 8 cadavers (5 males & 3 females) were embalmed with three types of embalming solution having different concentration of Phenoxyethanol. **Result & Conclusion:** Cadavers embalmed with solution number 3 having high concentration of phenoxyethanol and formalin diluted with saline were having a wide range of joint mobility with lifelike/realistic appearance of cadavers, soft consistency, elasticity, natural colour of skin and well preserved organs and muscles.

KEYWORDS

Embalming, Phenoxyethanol, cadavers.

INTRODUCTION

Preservation of cadaver plays important role in medical education, scientific research or tissue transplantation. It can be further used as artistic displays in museum and educatory exhibitions. The present is disposal of human cadavers and pleasantly kept in cryogenic containers without breaking the physical, legal and ethical issues for short duration. For many centuries scientists have tried to create effective and health safe method of conservation and long lasting preservation of corpses. Mummies and anatomic preparations created in the past have had many pros and cons which is the reason for continuous research today.(1&2)

In 1985, Bari Logan and his team firstly introduced new soft embalming solution named as The Cantabrian solution containing methanol for the replacement of formalin which maintained flexibility of specimens (3) later on Thiel's method was introduced in 1992 by Walter Thiel to preserves natural colours for prolonged time maintaining its plasticity, flexibility and texture. This method retains the body's natural look. Skin and muscles remain flexible, allowing the limbs to be moved, while the body's internal organs are clearly identifiable and respond to the surgeon's scalpel as if alive.(4) The other chemical solutions used for soft embalming are the Coleman and Kogan saturated salt solution (1998), the Larsen solution (2007), the modified Laskowsky solution (2007), the Al-Hayani Shellac mixture (2011), Goyri-o-neill embalming solution (2013), Hayashi saturated salt solution (2014), Gosomji saturated salt solution 2018, and the Natekar and De Souza glutaraldehyde solution (2014), (5,6,7,8,9,10,11) Natekar and De Souza observed that glutaraldehyde as the principal component of the embalming fluid was very effective in the preservation of cadavers for surgical dissections.(11)

Phenoxyethanol has not been used as a primary agent in arterial injection solutions for preservation purposes. However, there are two patents by Campbell in 1995 and Margrave in 1998 from the United States according to which a solution of glutaraldehyde, aromatic ether of ethanol like phenoxyethanol, humectant and an alcohol like ethanol.(12) A buffer of an anti oxidant can be added to the solution to maintain the stability of the solution. The pH must be maintained at 7-9. Additional substances can be added to prevent microbial growth in the solution.(13)

With increasing advancements in the field of research and advancement of new surgical technologies to learn various surgical procedures there is a need to get life like appearance of soft fixed cadavers with high joint mobility to run such kind of workshops. To

achieve this use of alternative embalming fluids especially phenoxyethanol are on the rise due to its properties related to preservation and non-toxicity. Phenoxyethanol preserved cadavers and specimens were found of soft consistency, colour and flexibility of joints to be suitable for dissection, demonstration and display purposes.

Thus, the present study was aim to introduce a new embalming fluid containing phenoxyethanol, to analyze and compare the outcomes of Phenoxyethanol based embalmed cadavers having different concentration of phenoxyethanol.

AIMAND OBJECTIVES:

1. To explore the use of phenoxyethanol solution for arterial embalming.
2. To evaluate the effectiveness of Phenoxyethanol as suitable alternative to formaldehyde for long term preservation of cadavers.
3. To obtain lifelike quality of soft-fixed cadavers for cadaveric surgical workshops.

MATERIAL AND METHODS

MATERIAL:

1. Graduated glass bottle, 10 litre with an outlet
2. Nozzle connected to transparent rubber tube with screw clamp to regulate rate of flow. Injecting needle or cannula
3. Scalpel with blade
4. Forceps
5. Scissor
6. Thread

Solutions

Solution A:

1. Formalin 5 litre
2. Spirit 2.5 litre
3. Glycerin 2 litre
4. Phenol 500ml
5. Phenoxyethanol 2% 5 litre
6. Thymol 100gm

Solution B:

1. Phenoxyethanol 7 litre
2. Glycerin 5 litre
3. Spirit 2.5 litre
4. Carbolic acid 1litre

5. Formalin 500ml
6. Thymol 100gm
7. Eosin 50gm

Solution C:

1. Phenoxyethanol 7 litre
2. Glycerin 6 litre
3. Spirit 2.5 litre
4. Carbohic acid 1 litre
5. Saline 1 litre + formalin 100ml
6. Thymol 100gm
7. Eosin 50gm

A Comparative observational study was conducted at Dr S.N. Medical College & Hospital Jodhpur. 8 cadavers (5 males & 3 females) between 34 to 85 years of age were taken for the study. All the cadavers were those who had opted to voluntarily donate their bodies before death for medical research purpose. 3 different types of Embalming solutions were used for embalming. Cadaver number 1,2,3 were embalmed with solution A, cadaver number 3 and 4 embalmed with solution B and rest 6,7 and 8 embalmed with solution C.

16 litre Solution different for all 8 bodies as noted before was prepared. After that an incision was given for exposure of common carotid artery. Pressure applied for embalming procedure was 10-12mm of Hg. 8 liter per day fluid slowly infused for consecutive 2 days and body was checked for complete embalming signs and thereafter cadaver no 1 & 2 placed directly in 10% formalin tank whereas rest of bodies were placed in deep freezer for 2 to 7 days at -4 degree temperature and further placed in 10% formalin tank. After this procedure cadavers were observed and dissected to see results.

RESULT AND OBSERVATIONS

A present study was conducted in the department of Anatomy, Dr. S.N. Medical College Jodhpur, Rajasthan from 2018 to 2023. Total 8 cadavers were embalmed by using three types of solutions having different concentration of formalin and phenoxyethanol for the purpose to obtain cadavers with soft consistency of skin muscles organs and maintained joint mobility. All of these cadavers were used in cadaveric orthopaedic surgery workshops and after that they used multiple time by UG and PG students over a period of >3 years. Even after 3 years no fungal growth was found and life-like appearance was retained including colour, elasticity and joint mobility.

Table:3 Movements on various joints

Solution	Cadaver no.	Shoulder joint				Elbow joint		Wrist joint				Inter-phalangeal joint		Hip joint				Knee joint		Ankle joint		
		F	E	Ab	Ad	F	E	F	E	Ab	Ad	F	E	F	E	Ab	Ad	F	E	PF	DF	
Solution -A	1.	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2.	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3.	-	+	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solution -B	4.	+	+	+	+	+	+	+	+	-	-	-	-	+	+	-	-	-	-	-	-	-
	5.	+	+	+	+	+	+	+	+	-	-	-	-	++	+	-	-	+	+	+	+	-
Solution -C	6.	++	++	++	++	++	++	+	+	-	-	+	+	++	++	+	+	+	+	+	+	+
	7.	++	++	++	++	++	++	+	+	-	-	+	+	++	++	+	+	+	+	+	+	+
	8.	++	++	++	++	++	++	+	+	-	-	+	+	++	++	+	+	+	+	+	+	+

- F: Flexion
- E: Extension
- Ab: Abduction
- Ad: Adduction
- PF: Plantar Flexion
- DF: Dorsi Flexion
- ++: Complete action
- -: Partial action

Table no 1 Shows Demographic characteristics of the cadavers. All cadavers were aged between 34 to 100 years. Out of these 5 were male and 3 were female, body weight ranges from 57 kg to 85 kg and height ranges were between 5 feet to 6.2 feet. All cadavers were bonafied residents of Rajasthan.

Table 2 shows the results of the assessment of the physical characteristics of the 8 cadavers.

Cadavers who were embalmed with type c solution having high concentration of phenoxyethanol were showing skin with less Pigmentation and natural colour restoration with blisters and higher

Table: 1 Age, Gender, Body weight and height of the cadavers

Cadaver Number	Age (year)	Gender	Body Weight (Kg)	Body Height (Feet)
1	85	Male	85	6.2 feet
2	89	Male	80	6 feet
3	86	Female	73	5.9 feet
4	34	Male	80	6 feet
5	100	Female	60	5.4 feet
6	74	Male	75	5.9 feet
7	77	Female	57	5 feet
8	75	Male	75	6 feet

Table:2 Physical characteristics of the cadavers

Cadaver no.	Skin				Muscle		Organs	
	Pigmentation	Elasticity	Blisters	Penetration	Well Preserved or not	Natural colour	Well Preserved or not	
1.	+	+	+	Slightly tougher	+	+	+ with less natural condition	
2.	+	Slight	+	+	+	+	+ with less natural condition	
3.	+	Slight	+	+	+	+	+ with less natural condition	
4.	-	++	+	++	+	+	+ with less natural condition	
5.	-	Slight	+	+	+	+	+ with less natural condition	
6.	-	++	+	++	+	+	+ with more natural condition	
7.	Reddish	++	+	++	+	+	+ with more natural condition	
8.	Reddish	++	+	+	+	+	+ with more natural condition	

Elasticity similarly muscles and organs showed life like appearance when compared with solution having higher amount of formalin. **(Photograph 1)**

Table no 3 shows cadavers embalmed with solution number 3 having high concentration of phenoxyethanol and formalin diluted with saline were having a wide range of joint mobility. All the proximal as well as distal small joint movements were also present. **(Photograph 2)**



Photograph : 1 showing high range of movements at various joints



Photograph :2 Showing well preserved organs and muscles

DISCUSSION

With the advancement on medical technologies and training methods for clinicians it is very important to advance the traditional cadaver preservation techniques also. It will help clinicians and surgeons to give hands on training experience before performing on patients

As the formalin was been used as chief preservative but it has lots of disadvantages like dark colouring of skin and stiffness in joints and above it has been proved potentially harmful for people working on cadavers. There are many studies experimenting with the embalming fluid and replacing formalin. In this study we have focused on decreasing amount of formalin and using phenoxyethanol as chief preservative.

In the present study we found that the cadavers who were embalmed with type c solution having high concentration of phenoxyethanol were showing skin with less Pigmentation and natural colour restoration with blisters and higher Elasticity similarly muscles and organs showed life like appearance when compared with solution having higher amount of formalin. Similarly cadavers embalmed with solution no 3 were having a wide range of joint mobility. All the proximal as well as distal small joint movements were also present. these finding of present study were in accordance with studies conducted by previous authors Tendon A et.al (14), Frolich K W et.al (15), Crosado B et.al (16), Sam Sik Shin et.al (17), Wineski L E, et.al (18), Richins et.al (19), Joy Y Batla et.al (20).

CONCLUSION:

In the present study we experienced that phenoxyethanol can be a replacement of formaldehyde for embalming of cadavers. As in the present study we observed lifelike/realistic appearance of cadavers, soft consistency, elasticity natural colour of skin, high mobility of joints, well preserved organs and muscles in cadavers who were embalmed with embalming solution having higher concentration of phenoxyethanol and little amount of formalin diluted with saline. In addition to avoiding the well known hazardous effects of formaldehyde, the use of phenoxyethanol also prevents pungent smell and other local & systemic manifestation of its toxicity because phenoxyethanol has a mild fruity smell. On the other hand this embalming solution can be used for postgraduate hands-on workshops for several medical disciplines.

REFERENCES:

1. Coleman R. Reducing the levels of formaldehyde exposure in gross anatomy laboratories. *Anatomical Record*. 1995 Dec;243(4):531-3.
2. Krivanek ND, Imbus HR. Formaldehyde studies on irritation at low levels. *Toxico* 1992; 4:315-330.
3. Logan B. The long term preservation of whole human cadavers destined for anatomical study. *Ann R Coll Surg Engl* 1983;65:333-8.
4. Thiel W. The preservation of the whole corpse with natural color. *Ann Anat* 1992;174:185-95.
5. Coleman R, Kogan I. An improved low-formaldehyde embalming fluid to preserve cadavers for anatomy teaching. *J Anat* 1998;192(Pt 3):443-6.
6. Brenner E. Human body preservation-old and new techniques. *J Anat* 2014;224:316-44.
7. Al-Hayani AA, Hamdy RM, El-Aziz GS, Badawoud MH, Aldaqal S, Bedir Y. Shellac: A non-toxic preservative for human embalming techniques. *J Anim Vet Adv*. 2011;10:1561-7.
8. Goyri-O'Neill J, Pais D, Freire de Andrade F, Ribeiro P, Belo A, O'Neill A, et al. Improvement of the embalming perfusion method: The innovation and the results by light and scanning electron microscopy. *Acta Med Port* 2013;26:188-94.
9. Hayashi S, Homma H, Naito M, Oda J, Nishiyama T, Kawamoto A, et al. Saturated salt solution method: A useful cadaver embalming for surgical skills training. *Medicine (Baltimore)* 2014;93:e196.
10. Gosonji JJ, Omirinde JO, Hena SA, Wanmi N, Azeez IA. Saturated salt solution an alternative reagent in reducing formaldehyde concentration in embalming. *MOJ Anat & Physiol* 2018;5:205-7.
11. Natekar PE, De Souza FM. Glutaraldehyde: A new embalming chemical composition for preservation of cadavers for innovative surgical procedures. *IJA* 2014;3:39-44.
12. James W. Campbell; John L. Margrave, Preservative and Embalming fluid. *TeX*. Patent Number: 5,827,511 Date of Patent: *Oct.27,1998.
13. Suniti Raj M, Jigyasa P, Rahul S, Raveena S, Sushobhana, Priyanka S. Embalming fluid- Modified composition for hot and humid places. *Int J Anat Res* 2016, Vol4(3):2531-35.

14. Tandon A, Bhatnagar R, Pokhrel R, Solanke K. Phenoxyethanol as a formaldehyde removing agent for long-term preservation: Our experience. *Eur J Anat* 2014;18(4):267-72.
15. Frolich KW, Endresen LM, Knutsen A, et al. Phenoxyethanol as a non-toxic substitute for formaldehyde in long term preservation of human anatomical specimens for dissection and demonstration purposes. *Anat Rec* 1984;208(2):271-8.
16. Crosado B, Löffler S, Ondruschka B, Zhang M, Zwirner J, Hammer N. Phenoxyethanol-Based Embalming for Anatomy Teaching: An 18 Years' Experience with Crosado Embalming at the University of Otago in New Zealand. *Anat Sci Educ*. 2020 Nov;13(6)
17. Sam Sik Shin, Hyung Chae Yang, and Kwang Il Nam. Suitability of Ethanol-Glycerin Embalming Cadavers for the Training of Human Anatomy. *Korean J Phys Anthropol*. 2016;29(4):155-165.
18. Wineski LE, English AW. Phenoxyethanol as a nontoxic preservative in the dissection laboratory. 1989; 136(2):155-8.
19. Richins CA, Roberts EC, Zeilmann JA. Improved fluids for anatomical embalming and storage. *Anat Rec*. 1963; 146:241-243.
20. Balta JY, Twomey M, Moloney F, Duggan O, Murphy KP, O'Connor OJ, Cronin M, Cryan JF, Maher MM, O'Mahony SM. A comparison of embalming fluids on the structures and properties of tissue in human cadavers. *Anat Histol Embryol*. 2019 Jan;48(1):64-73.