



Original Research Article

Modified saturated salt solution (MSSS) method for embalming

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ABSTRACT

Introduction: Surgical specialty requires adequate exposure of training and enormous practice of surgical skills to become successful. Moreover, surgeons have to be familiar with day to day trending newer developments and surgical techniques. For exclusive surgical training in surgical methods, the current adopted approach is surgical skills training (SST) on cadavers. Even though live animals and low and high fidelity simulators are used for SST, the overall outcome is in low profile with high cost and compromised anatomic fidelity, compared to embalmed cadavers. Within the available methods for embalming cadavers, formalin solution method (FAS) embalmed cadavers are seldom used for SST, Thiel's solution method (TS) is costly, and saturated salt solution method (SSS) is preferred nowadays.

Materials and Methods: It is a descriptive study for a period of six months in the formalin solution (FAS) embalmed and modified saturated salt solution (MSSS) method of embalmed cadavers. Human donated corpses with intact skin and organs of the body with acceptable appearance were included. The corpses with breached skin, external injuries and unacceptable appearances were excluded from the study. Two corpses embalmed were by MSSS, assessed for skin color, pliability and suppleness of the soft tissue by visual and tactile assessment, range of movements and the results are compared with two formalin solution (FAS) embalmed cadavers. The data were analyzed by SPSS26 and excel 2007 software.

Implications: MSSS method is useful, cost effective and comfortable embalming technique for surgical skills training.

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1. Introduction

Cadaveric dissection is a memorable experience of an under graduate medical student's carrier. In his postgraduate period too he needs to get trained in various surgical procedures which may not be possible in vivo, could be achieved through specially embalmed cadavers. More over surgical field itself is an ever growing one and the students, faculties are expected to update their surgical skills with emerging techniques. The available options for surgical skills training (SST) are live animals, high-fidelity simulators.¹ Investment and difficult assessment of the results are the drawbacks met with the above said practices.² Worldwide routinely used cadavers for SST are fresh frozen cadavers (FFC).³ The advantage being, live color, natural

texture and comfortable maneuverability. Disadvantages of FFCs in SST are limited usage period, chances of infection, need for meticulous storage space and adequate waiting time for thawing.⁴⁻⁸

Even though the conventional method of embalming, the formalin solution (FAS) methods available for SST, unacceptable factors of this method are rigidity of tissues, unpleasant smell of formalin and the discolored structures. Thiel's solution (TS) method which involves preparation of five cumbersome and costly solutions namely 1. stem-I, 2. stem-II, 3. stem-III, 4. stock solution and 5. final solution. It really needs lot of time, energy, manpower and money.⁹⁻¹⁴ Even though this method is widely used, for its life like preservative effects it has its own disadvantages as disintegration of the muscular system and narrow work period.¹⁵ Logan came with a technique of cadaveric embalming which uses less amount of formalin

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and routine use of glycerin, alcohol, phenol. Coleman and Cogan further modified this solution by reducing the amount of formalin and added more of Sodium Chloride. They claim that the preservation was comparable to the Thiel's Solution in terms of appearance, pliability, cost and procedure friendliness.¹⁶

2. Materials and Methods

Four adult cadavers, two male and two female, were utilized for this study. Two cadavers were embalmed by formalin solution (FAS) method and two cadavers were embalmed with modified saturated salt solution (MSSS) method. The ingredients of MSSS solution was sodium chloride 4 kg, 20% formaldehyde 250ml, phenol 500ml, glycerin 250ml, isopropyl alcohol 1.0 L, water 5.0L and total of 7.0 L for each cadaver. The solution was injected through femoral artery into one male and one female cadaver for six hours each (MSSS method). The other pair was embalmed by formalin (FAS) solution method with usual fixed composition namely 20% formaldehyde 4.0 L, phenol 0.4L, glycerin 1.0L, water 10.0L and total of 15.4L for 2 cadavers.

The data was collected through the feedback form (Tables 1 and 2), under the following criteria namely appearance of the cadaver, smell, incision/closure, maneuverability and range of movements (ROM) for each set of cadavers separately (visual and tactile assessment method). Table 1, shows the feedback of MSSS vs FSS, and Table 2 shows the feedback of FSS vs MSSS method of embalmed cadavers (dual single blinded). The feedback was obtained for twice from the participants to reassure the quality of this research. Data was collected from the feedback of 34 participants of a cadaveric workshop (cadaveric workshop on ultrasound-guided biopsy of liver, kidney, thyroid and muscle) at ASTRA (advanced surgical training and research academy) cadaver lab, Shri Sathya Sai Medical College and Research Institute, Ammapettai, Thiruporur taluk, Kanchipuram district, Tamilnadu-603108. The data was analyzed using SPSS 26 and excel 2007 software.

Tables 1 and 2 Showing the proforma and collected data

3. Results

67.65% of the participants felt the MSSS method embalmed cadavers were better than the formalin solution embalmed cadavers with respect to appearance and 26.47% participants felt good and 5.88% felt no difference. None has told bad or worst about the appearance of the cadavers embalmed by MSSS over FAS method. Smell wise 70.59% of the participants felt the MSSS method embalmed cadavers are better than formalin solution embalmed cadavers and 23.53% felt good and 5.88% felt no difference. No one felt either bad or worst. Ability to perform incision/closure was better for 58.82%, good for 35.29%

and no difference for 5.88% of participants. None felt either bad or worst in MSSS vs FAS method of embalming when both the set of embalmed cadavers were compared for performing incision or closure. During surgical skills training (SST) maneuverability of the procedures were better for 52.94%, good for 32.35% and no difference for 14.71% of the participants. None felt either bad or worst for MSSS method embalmed cadavers with respect to maneuverability. Range of movements of the MSSS method embalmed cadavers were better for 52.94%, good for 23.53%, and no difference for 8.82%, bad for 14.71% and worst for 0.00% of the participants.

11.76% of the participants felt the FAS method embalmed cadavers were good than the MSSS embalmed cadavers with respect to appearance and 5.88% participants felt no difference between FAS and MSSS method of embalming and 61.76% of the participants felt bad appearance of the FAS embalmed cadavers and 20.59% felt worst with respect to appearance of the cadavers. Smell wise 5.88% of the participants felt there was no difference between FAS and MSSS method of embalmed cadavers and 70.59% felt FAS embalmed cadavers are bad and 23.53% of the participants felt worst with respect to smell of the FAS embalmed cadavers. Neither of the participants felt the FAS method of embalmed cadavers better nor good. 14.71% of the participants felt good when performing incision or closure on the FAS method embalmed cadavers compared to MSSS embalmed cadavers and 5.88% of the participants felt no difference between the cadavers of either of the methods, 52.94% felt bad and 26.47% had worst experience with FAS embalmed cadavers over MSSS embalmed cadavers. When both the set of embalmed cadavers were compared for maneuverability of the procedures during surgical skills training (SST) 8.82% of the participants felt better, 2.94% felt good, 14.71% felt no difference, 58.82% felt bad and 14.71% had worst experience with FAS method of embalmed cadavers. Range of movements of the FAS method embalmed cadavers were better for 2.94% of the participants, good for 5.88%, and no difference for 8.82% and bad for 50.00%. 32.35% of the participants had worst experience during range of movements of the cadavers with the FAS embalmed cadavers over MSSS method of embalmed cadavers.

4. Discussion

Embalming of the dead has been practiced since ancient times. Since the Egyptians successfully embalmed bodies and the earliest Biblical texts refer to the practice, salt appears to have been used in the embalming process. Ambroise Pare (1510–1590), who is considered as one of the fathers of surgery, a pioneer in surgical techniques, and an anatomist, described that he used “common salt” as a component of his embalming solution.¹⁷

Table 1: Feedback for MSSS over FSS method embalmed cadavers

S. no	Criterion	Better	Good	No difference	Bad	Worst
1	Smell	24	8	2	0	0
2	Incision	20	12	2	0	0
3	Appearance	23	9	2	0	0
4	ROM of Joints	18	8	3	5	0
5	Maneuverability	18	11	5	0	0

Table 2: Feedback for FAS over MSSS embalmed cadavers

S. no:	Criterion	Better	Good	No difference	Bad	Worst
1	Smell	0	0	2	24	8
2	Incision	0	5	2	18	9
3	Appearance	0	4	2	21	7
4	ROM of Joints	1	2	3	17	11
5	Maneuverability	3	1	5	20	5

Thus, the use of common salt in embalming cadavers for advancing surgical skills has a long history. On the contrary, the extensive use of formalin as a curing and preserving agent is based on its excellent antiseptic properties, which prevent the entry of putrefying organisms; it also tans tissues without destroying their delicate structure.¹⁸ With reference to Coleman and Kogan,¹⁹ the SSS method used in his study contained just 0.8% Formaldehyde. In this study(MSSS) we have used reduced amount of formaldehyde (250ml of 20% formalin for each cadaver) in terms of concentration and amount to combat the unwanted side effects of formaldehyde namely the stiffed and discolored tissues.²⁰ An analysis of the usefulness of cadavers in anatomy education takes into account the importance of cadavers, considered “silent teachers”, as they teach things that books or 3D software cannot, such as the anatomical variability between individuals, the effect of diseases or lifestyle on the body and the different textures and behavior of tissues.²¹

Balta et al., demonstrated that surgical training has been successful in almost all areas using Thiel-embalmed cadavers. The appearance similar to the living body increases the risk of emotional and psychological impact on students after their first dissection session.^{22,23} However, the surgeons evaluated SSS and TS-embalmed cadavers as the same. Furthermore, the evaluation of SSS-embalmed cadavers did not vary much between surgeons in comparison with that of TS-embalmed cadavers.²⁴ It is known that TS-embalmed specimens presented considerable changes in their histological appearance.^{25,26}

5. Conclusion

This study proved that the modified saturated salt solution (MSSS) method of embalming cadavers for surgical skills training (SST) is an acceptable method in terms of smell, incision/closure, appearance, range of movements and maneuverability during surgical skills training. More over this method (MSSS) is cost effective and less time

consuming affair of embalming cadavers for Surgical Skills Training (SST) in cadaver labs.

Practical difficulties of the FAS method with respect to the uncomfortable smell of the conventional formalin embalmed cadavers are rectified by this MSSS method. Moreover the additional benefits like life like color of the tissues are on par with the Theil’s method of embalming which is the gold standard in many of the institutes. Furthermore the procedure friendly method of preparing the MSSS method of embalming solution with minimal cost effective ingredients plays a major role in the success of this method in future.

6. Source of funding

None.

7. Conflict of interest

None.

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