

Cadaver embalming and fixing solutions from past to present

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Abstract

Cadaver and organ embalming-fixing solutions have a long history. The aim of this study is to follow this historical adventure step by step and to consider the point of embalming and fixation solutions. This study was carried out on the literature published to Google Scholar, PubMed, and Science Direct between 2000 and 2021. During the search, "cadaver, cadaver dissection, cadaver detection, cadaver use, cadaver embalming, cadaver preservation and organ preservation" were chosen as keywords. The discovery of formaldehyde in 1869 was clearly a turning point for cadaver and organ embalming-fixing solutions, and formaldehyde-based solutions are widely used even today. However, in addition to formaldehyde-based solutions, there are methods such as plastinization, paraffinization, resin embedding methods. It is clearly seen in the literature that formaldehyde-based solutions have serious side effects in terms of human health. Therefore, scientists have developed different methods. However, these methods have both application difficulties and accessibility problems compared to formaldehyde-based methods. Solutions that can prevent these problems should be produced in a short time.

Key words: cadaveric fixation, cadaver embalming, cadaver protection

Introduction

The cadaver is an indispensable element of education in order to maintain anatomy education and to process it in a healthy way. In order for the cadaver to be used for training purposes, a preliminary process called embalming and fixation is required [1-3]. Embalming and fixation reduce the risk of infection and ensure that the cadaver is used and stored for many years. There are some differences between these two methods, such as the solution used and the method of application. Thiel is the most commonly used solution for embalming, while formaldehyde is the most commonly used solution for fixation. This chemical difference creates some differences about the flexibility, internal structure and integrity of the cadaver [4-7]. While the solutions used in embalming are generally applied on the cadaver, the solutions used in the fixation process are injected into the veins. This injection is usually performed using the common carotid artery, femoral artery, and femoral vein. However, if the integrity of the cadaver is impaired or there is any problem in the veins, it is performed in regional applications. The amount of solution given during injections and the rate of administration directly affect the quality of cadaver detection [7, 8].

Preservation of cadavers and organs dates back to the 6000s. Social and religious beliefs are among the most important reasons why it dates back to ancient

times. Because for most societies, death is seen as a sacred event and man is seen as God's representative on earth. Also, in most ancient cultures such as Egypt, the preservation of the body meant eternal life. It was believed that if the integrity of the body was broken or it started to rot, this person was expelled from the hereafter. For this reason, it is of great importance for individuals to store the cadaver properly for many years. In ancient times, salt, alcohol and herbal mixtures were used to preserve cadavers and organs [8-11]. In the Middle Ages, it was common for mummification to remove organs, immerse the whole body in solutions, and plant plants in different parts of the body. In the following years, the idea of giving embalming solutions to the circulatory system became widespread. In 1326, Alessandro Giliani made attempts to introduce solutions into the vascular system. Leonardo Da Vinci, one of the important anatomists of the century, injected the liquids (lavender oil, sodium nitrate, turpentine) prepared for fixation into the ventricular and arterial system of the cadaver. In the 18th-19th centuries, American Thomas Holmes became the father of modern mummification with his work with alcohol and various chemicals on 4000 soldier cadavers. The discovery of formaldehyde by August Wilhelm von Hofmann in 1869 was a turning point for cadaveric detection. A very short time later, Laskowski developed the Geneva fixation solution using glycerin to prevent the cadaver from hardening

and drying out. Since these dates, many cadaver detection solutions based on formaldehyde have been developed [1, 8, 10, 11]. It is available in different methods as well as formaldehyde-based solutions. For example, plastination, paraffinization, epoxy resin embedding, alkyd resin [12-14] methods are also available [15]. Plastination was established in 1978 by Prof. Dr. It was found by Gunther von Hagens at the institute of anatomy and pathology at the university of Heidelberg [16]. The paraffinization method was developed by Deegener and Brendt in 1914 [17].

The aim of this study is to reveal the adventure of cadaveric and organ Deciphering solutions from the past to the present, the differences between each other, advantages, disadvantages and the point at which it has come.

Material and methods

The study was conducted using the Pubmed, Google Decadal and Science Direct search engines. The keywords “cadaver, cadaver dissection, cadaver detection, cadaver Decontamination, cadaver embalming, cadaver preservation and organ preservation” were entered into the search engines

for scanning and a detailed scan was performed. During the search, articles that were not suitable for our purpose were decommissioned. The screening years were deciphered between 2000-2021. About 97,900 articles were found that matched the keywords. Later, 21 of these articles were selected.

Results

As a result of the literature search, it was clearly seen that cadaver and organ preservation procedures date back to very ancient times and have gained a serious path with the discovery of formaldehyde (Table 1). It was observed that formaldehyde-based solutions continue to be widely used today (Table 2). However, it is clearly reported that formaldehyde-based solutions have serious side effects on the health of expert anatomists working in this field, and are even a carcinogenic substance. In order to cope with these side effects and to better preserve the integrity of the cadaver, various methods are being applied today. The main ones are plastination and resin embedding methods. The spread of these methods has a serious importance for the health of anatomists and health students.

Table 1 Significant developments in cadaver embalming and detection

Year/Century	Important Developments
15-16. century	The first injection for detection was made into the cadaver by Leonardo Da Vinci.
18-19. century	Thomas Holmes (the father of modern embalming) performed embalming on 4000 cadavers of soldiers using alcohol, arsenic, mercury.
1869	August Wilhelm von Hofmann discovered formaldehyde.
1886	Laskowski used glycerin to prevent the cadaver from drying out and developed the Geneva solution.
1914	The paraffinization method was developed by Deegener and Brendt.
1978	Prof. Dr. Gunther von Hagens discovered plastination.

Table 2 Formaldehyde-based solutions

Name of The Solution	Contents of the Solution
Erskine	Formaldehyde, Ethyl Alcohol, Phenol, Glycerin, Sodium Arsenate, Salicylic Acid, Chlorthymol
Spence	Formaldehyde, Methyl Alcohol, Water Glycerin, Phenol
Larssen	Formalin, Distilled Water, Sodium Chloride, Sodium Bicarbonate, Chloral Hydrate, Sodium Sulphate
Norville	Formaldehyde, Sodium Nitrate, Glycerin, Citronel oil, Borax, Boric Acid, Eosin
Cambridge	Formaldehyde, Water, Ethanol, Polyethyleneglycol, Citricidal
Theil	Formalin, Alcohol, Boric Acid, Ammonium Nitrate, Sodium Sulphate, Potassium Nitrate, Propylene Glycol, Stock II, Morpholine
Modifiye Larssen	Formalin, Sodium Sulphate, Sodium Bicarbonate, Water, Glycerol, Chloral Hydrate, Sodium Chloride
Logan	Formaldehyde, Phenol, Alcohol, Glycerin
Saturated Salt Solution	Formaldehyde, Phenol, Salt, Isopropyl Alcohol, Water, Glycerin

Conclusion

The discovery of formaldehyde was a turning point in the embalming and fixation of cadavers and organs. One of the most important pillars of this turning point is that formaldehyde is easy and accessible [1, 3, 8]. However, in addition to these advantages of formaldehyde, it also has many disadvantages. Experimental studies have shown that formaldehyde both causes various diseases in the respiratory, nervous, reproductive and digestive systems and has a carcinogenic effect. In the respiratory system, inflammation in the nose and throat, pulmonary edema, cough, pneumonia, lung cancer, embryo deaths in the reproductive system, fertility, cryptorchidism, perforation in the digestive system, ulcer, diarrhea, stomach inflammation, abdominal pain, mutation in the nervous system, tumor, behavioral disorder, It has been clearly stated in the literature that it causes headache, epilepsy and anamol [17-20]. These harmful effects of formaldehyde have led scientists to find methods that will threaten human health less. As a

result, plastination and resin embedding methods, which are less harmful to human health, have been developed. Although the cadaver and organ to be preserved during the plastination process are exposed to many chemicals, this rate is reduced to a minimum during use and becomes less threatening to health [16, 21].

Cadaver and organ solutions have made a serious progress over time, and this way has made it less threatening to the health of individuals working and trained on cadavers and has made the cadaver to be used more effectively for many years.

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References

1. Ruhsar E, Demiraslan Y. The Solutions Used in Cadaver Preparation and the Current Approaches. *Dicle Üniversitesi Veteriner Fakültesi Dergisi*. 2018;11(2):105-8.
2. Bilge O, Çelik S, Boduç E. Plastination of old fixed locomotor system specimens and usage in education. *Ege Tıp Dergisi*. 2014;53(2):84-7. <https://doi.org/10.19161/etd.344058>
3. Taşkın Rg, Şafak Nk, Yücel Ah. Comparative Examination of Cadaver Fixation Solutions. *ERÜ Sağlık Bilimleri Fakültesi Dergisi*. 2019;6(2):21-5.
4. McDougall S, Soames R, Felts P. Thiel embalming: Quantifying histological changes in skeletal muscle and tendon and investigating the role of boric acid. *Clin Anat*. 2020;33(5):696-704. <https://doi.org/10.1002/ca.23491>
5. Balta JY, Twomey M, Moloney F, Duggan O, Murphy KP, O'Connor OJ, et al. A comparison of embalming fluids on the structures and properties of tissue in human cadavers. *Anatomia, histologia, embryologia*. 2019;48(1):64-73. <https://doi.org/10.1111/ah.12412>
6. Völlner F, Pils U, Craiovan B, Zeman F, Schneider M, Wörner M, et al. Stability of knee ligament complex of Thiel-embalmed cadaver compared to in vivo knee. *Journal of the mechanical behavior of biomedical materials*. 2017;71:392-6. <https://doi.org/10.1016/j.jmbbm.2017.04.009>
7. Hammer N, Löffler S, Feja C, Sandrock M, Schmidt W, Bechmann I, et al. Ethanol-glycerin fixation with thymol conservation: A potential alternative to formaldehyde and phenol embalming. *Anatomical sciences education*. 2012;5(4):225-33. <https://doi.org/10.1002/ase.1270>
8. Ortadeveci A, Semih Ö. Kadavra Tarihi, Kadavra'nın Türkiye ve Dünya'da Anatomi Eğitiminde Kullanılması ve Fiksasyon. *Türk Dünyası Uygulama ve Araştırma Merkezi Klinik Anatomi Dergisi*. 2017;2(1):21-38.
9. Canbolat M, Şenol D. A Potential Source In Embalming And Dissection Education: Health Tourism. *Tıp Eğitimi Dünyası*. 2019;18(54):88-91. <https://doi.org/10.25282/ted.460566>
10. Brenner E. Human body preservation - old and new techniques. *Journal of Anatomy*. 2014; 224(3):316-44. <https://doi.org/10.1111/joa.12160>
11. Balta JY, Cronin M, Cryan JF, O'mahony Sm. Human preservation techniques in anatomy: a 21st century medical education perspective. *Clinical Anatomy*. 2015; 28(6):725-34. <https://doi.org/10.1002/ca.22585>
12. Keleş H, Çınaroğlu S. Comparison of texture and color values of rat digestive system organs prepared with fresh and alkyd resin. *Erciyes Üniversitesi Veteriner Fakültesi Dergisi*. 2019;16(3):198-203. <https://doi.org/10.32707/ercivet.648561>
13. Çınaroğlu S, Ari Hh. Investigation of macro anatomy of the urogenital system organs of norduz sheep by using the method of alkyd resin and preparation of their cadavers. *Van Veterinary Journal*. 2015;26(3):129-39.
14. Çınaroğlu S, Ari Hh. Investigation of Macro Anatomy of The Urogenital System Organs of Norduz Sheep by Using The Method of Alkyd Resin and Preparation of Their Cadavers. *Van Veterinary Journal*. 2015;26(3):129-40.
15. Arı H, Çınaroğlu S. A new approach to preservation of some organs using alkyd resin. *Research in veterinary science*. 2011;90(1):16-9. <https://doi.org/10.1016/j.rvsc.2010.05.017>
16. Üstün Ç. Plastination. Is it a Science or a Freak Show? *Meandros Medical And Dental Journal*. 2002;3(1):37-42.
17. Kurt E, Yurdakul SE, Ataç A. An overview of the technologies used for anatomy education in terms of medical history. *Procedia-Social and Behavioral Sciences*. 2013;103:109-15. <https://doi.org/10.1016/j.sbspro.2013.10.314>
18. Ünsaldı E, Çiftçi Mk. Formaldehyde and its Using Areas, Risk Group, Harmful Effects and Protective Precautions Against it. *Yüzüncü Yıl Üniversitesi Veteriner Fakültesi Dergisi*. 2010;21(1):71-5.
19. Zararsız İ, Kuş İ, Yılmaz H, Köse E, Sarsılmaz M. Antioxidant Effects Of Omega-3 Fatty Acids on Experimental Formaldehyde Toxicity induced Injury of Hippocampus. *Ulusal Anatomi Kongresi*. 2008; 22(2):26-9.
20. İltar K, Zararsız İ, Ögetürk M, Yılmaz Hr, Sarsılmaz M. Testicular SOD, GSH-Px and MDA Levels in Experimental Toxicity of Formaldehyde and Protective Effect of ω -3 Fatty Acids. *Fırat Tıp Dergisi*. 2008;13(1):1-4.
21. Okan E, İnsal B, Bakıcı C, Haziroğlu Rm, Akgün Ro. Whole Body Silicone Plastination of Snakes with Cold-Temperature Technique. *Dicle Üniversitesi Veteriner Fakültesi Dergisi*. 2014(1):1-14.