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THE MYTH OF FORMALDEHYDE GAS PHASE EMBALMING

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ABSTRACT: The common misconception that formaldehyde gas fumes significantly embalm tissues in typical human embalming scenarios is fully discussed and debunked. Controlled laboratory studies on various tissue types demonstrate that no significant embalming occurs under any circumstances. Justification for the use of extremely pungent high-index, hign-fuming formaldehyde fumes is shown to be invalid for typical human embalming situations. Various types of aldehyde-based fluids for embalming are discussed and compared. Recommendations for proper use and techniques for exposure control are summarized.

INTRODUCTION: A vary pervasive and persistent misconception concerning the ability of formaldehyde fumes to exert an embalming effect on human tissue exists within the embalming profession. In fact, it has been elevated to the status of a famous wives tale and is always a topic of conversation at meetings and educational seminars. In my numerous meetings and educational seminars across the country the question or statement concerning formaldehyde gas phase embalming and its importance in embalming always comes up or is commented on.

Despite the continual references to formaldehyde fumes and their embalming abililty, no one has demonstrated or proved that they exert any significant embalming effect at all. Everyone who believes in this concept accepts it on face value alone or professes that it is a commonly agreed upon concept. Usually, someone will say it was mentioned and discussed in embalming college.

The ability of formaldehyde fumes to embalm gross tissues is usually cited as the justification for dangerous levels of formaldehyde exposure in embalming rooms. It is a reason that many embalmers will use high index, high fuming pungent formaldehyde based chemicals with high levels of volatile alcohols for difficult embalming cases and all cavity embalming. The benefit derived from the fumes in embalming justifies the increased levels of exposure to formaldehyde during the embalming process. Formaldehyde's gas phase embalming ability is also cited as one of the major differences from glutaraldehyde

embalming which is a liquid at room temperature. Formaldehyde is supposedly superior in embalming and particularly in cavity-type embalming due to its ability to generate significant fumes and permeate the tissues of the cavities. Glutaraldehyde, on the other hand, is a liquid and generates very low levels of airborne exposures even under worst case embalming scenarios where no ventilation is used and no exposure precautions are taken.

It was decided that the concept of formaldehyde gas phase embalming should be investigated and put to rest once and for all. We consequently conducted a very tightly controlled laboratory research into formaldehyde's ability to embalm through the gas phase only. The results were quite surprising and in direct contradiction with the common knowledge that is present in the embalming profession.

METHOD AND RESULTS: To conduct an extensive test of formaldehyde's ability to embalm in the gas phase versus it's ability to embalm when in actual liquid contact with tissues, the following test method was employed.

Numerous tissue samples of various typical tissues that would be encountered during embalming were subjected to separate exposures to formaldehyde in liquid solution and to formaldehyde fumes only. The tissues included heart, lung, intestinal and abdominal wall tissue sections. In addition, for added comparison, the tissue samples were also subjected to a 15% glutaraldehyde solution and subsequently analyzed.

The tissue samples were subjected to a closed atmosphere at room temperature of the concentrated fumes from a formaldehyde solution that was equivalent to a greater than 50 Index formaldehyde embalming fluid. The tissue samples were within 2 millimeters of the actual solution, but at no time were allowed to come into physical contact with the liquid solution. The samples were removed and examined under magnification at 1 hour, 2 hours and 8 hours. The atmosphere within the closed vessels, of course, yielded astronomical exposure readings exceeding 100 ppm. In addition, separate tissue samples of identical tissues types were submerged in the formaldehyde solution for equal times as the gas phase only exposures. As a final comparison, identical tissue samples were also submerged in a 15% glutaraldehyde solution for identical lengths of time as all other tissue samples. All submerged tissue samples were then examined under magnification and gross examination.

The tissue samples that were subjected to formaldehyde in the gas phase only were found to have only superficial and insignificant preservation and embalming action. The apparent preservation did increase with time with the 8 hour samples showing the most embalming appearance. However, all samples from the gas phase exposure showed only slight penetration and preservation of only 5-10% of the total sample. Some samples showed only the most superficial and slight graying and drying on the surface and with no appreciable preservation or embalming action evident. All samples that were subjected to the formaldehyde gas phase only would have been judged by any embalmer as not preserved or embalmed.

The tissue samples that were submerged in the formaldehyde solution, as expected, showed considerable preservation and embalming action. This effect increased with time as the 8 hour samples

showed the most significant preservation and embalming action. Usually at least 50-80% of the entire tissue sample was thoroughly embalmed after the submerged exposures. In addition, the tissue samples that were submerged in the 15% glutaraldehyde solution were as well embalmed or better as the other submerged samples. The glutaraldehyde samples showed equal penetration and embalming action with less apparent dehydration and drying of the tissue samples. The samples exhibited a leathery pliability and appeared to be less brittle and exhibited less total shrinkage than the formaldehyde submerged samples. Overall preservation and embalming action of all submerged samples was judged good to excellent for embalming purposes.

DISCUSSION: From our research, it is apparent that formaldehyde gas phase embalming of gross tissues in human cadavers is not a reality. No significant embalming of any consequence was exhibited on any of the tissues that were subjected to formaldehyde gas fumes only. Significant embalming of tissues will only occur when formaldehyde is presented to the tissues at the liquid-tissue interface at the embalming site. Formaldehyde gas shows no ability to permeate, migrate or infuse tissues and thusly demonstrates no embalming ability in the gas phase.

Both formaldehyde and glutaraldehyde show significant embalming ability when presented to gross tissues in a liquid medium. This is obviously the case during normal embalming of human remains with the result being significant preservation of the body. The extent and effectiveness of embalming is also demonstrated to increase with time of exposure to the chemicals. The tissues with the longest exposures to the liquid chemicals showed the most extensive embalming with the saturation and penetration of chemicals being greater as time of exposure increased.

These findings further emphasize the importance of adequate and proper cavity treatment as a mandatory adjunct to good embalming. Adequate liquid chemicals for tissue contact with the viscera must be present for satisfactory embalming to be achieved. Formaldehyde gas fumes cannot be counted upon to diffuse to areas that have not received liquid chemicals. If any necrotic pockets or so called hot spots exist, they must be treated with liquid chemicals or they will not be embalmed. Embalming only occurs at the liquid-tissue interface and not as a result of gas phase exposure.

The old recommendations of adequate and thorough aspiration, particularly of the lower areas, followed with injection of sufficient liquid cavity chemicals in the higher areas of the cavity still rings true. The importance of reaspiration and reinjection of additional cavity chemical cannot be overlooked. Invariably, cavity embalming problems are eliminated when reaspiration and reinjection are implemented as the cavity embalming procedure. Our research indicated that almost all significant embalming of the cavity has occurred after 3-4 hours and complete reaction at 8 hour time frames. Consequently, it is always beneficial to reaspirate as the embalming reaction is essentially over and any liquids left to be reaspirated in the cavities are essentially reacted and of no further value. Removal of these liquids eliminates potential purges or leakages. Reinjection of cavity chemicals will further the embalming of tissues in the cavity.

Remember that all the fumes noted in the air are lost to embalming. The hope that the use of high index, pungent formaldehyde chemicals will significantly help in the embalming of the cavities

or other tissues by gas diffusion is false. The major exposure hazards to formaldehyde fumes does not justify the false sense of security that many embalmers place in high index formaldehyde embalming chemicals. In addition, gas generating chemicals contribute to purge and other pressure related embalming problems and they offer no positive benefits as they do not embalm what they do not contact in the liquid phase.

Our extensive ongoing research indicates that complex low-fuming multi-aldehyde based non-formaldehyde fluids work best with the potential for the least exposure and deliver the most effective embalming in the safest way possible. Viscous, controlled reacting chemicals that are buffered and pH balanced that are glutaraldehyde, multi-aldehyde and phenolic based in a multi-alcohol delivery system exhibit the maximum embalming, penetration and sanitation. These types of chemicals offer the most hope for embalming as we approach the next century.

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