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Preservation of a Dog Heart Using Silicone Oils: A Second Approach

C. Wayne Smith

D. L. Hamilton

Conservation Research Laboratory/Archaeological Preservation Research Laboratory

Texas A&M University

Currently, the use of formalin and formaldehyde-based solutions have been the most common curation procedures for the post-mortem preservation of tissues and whole organs. Alternative methods of tissue preservation do exist. Plastination processes have produced good results, and specimens preserved using these processes do not require wet storage. Plastination however, is an expensive and time-consuming process.

Many routine processes used for the conservation of archaeological organic materials at the Conservation Research Laboratory at Texas A&M University provide a different perspective concerning the treatment of biological tissues. Using a process known as silicone bulking, we have successfully stabilized and conserved a variety of organic materials, including waterlogged archaeological artifacts and whole organs retrieved employing routine necropsy procedures. Notably, the total time required to preserve tissues utilizing silicone bulking processes is relatively short compared to other established processes.

The heart of a large dog was chosen for this experiment. Immediately following its removal, the heart was flushed with running water and soaked in a series of cold water baths maximize the removal of blood from the tissues. The heart was then stored for the remainder of a twenty-four hour period in a 50:50 solution of cold tap water and methanol. After twenty-four hours, the heart was placed into a second container containing 100% alcohol. In this phase of treatment, one half ounce of thiourea and one ounce of photo-flo were mixed into the methanol and the process of dehydrating the organ continued for twenty-four hours. After the second period of treatment in alcohol, the heart was placed into a stainless steel container with one liter of acetone. This container was then placed into a freezer-mounted vacuum chamber and a vacuum of 28 Torr was applied for eight hours. The heart was then left in the acetone solution in the freezer and allowed to sit at ambient pressure for the remainder of the twenty-four hour period.

The next morning, the heart was placed into a fresh bath of acetone and the process was repeated. After this second treatment in acetone, it was removed from the freezer and briefly examined prior to its placement into a third bath of acetone, containing one gram of thiourea and returned to the freezer-mounted vacuum chamber for an additional four hours of vacuum treatment at 28 Torr. After four hours, the heart was removed from the acetone solution and allowed to drain of free-flowing acetone. The heart was then transferred to a plastic container and 500 milliliters of PR-10 silicone oil was poured into the container completely submerging the specimen in silicone. Care was taken to ensure that the heart was sitting in a upright position during this process, because the main arteries had been cut in such a way that in this position trapped air was more easily displaced with silicone oils. Large bubbles that occurred at this stage suggested that oils were free-flowing into the larger arteries and vessels of the heart. In preparation for bulking, a section of mesh screen was placed on top of the heart to ensure that the organ remained completely submerged in silicone oils throughout the displacement process.

This container was placed into the freezer-mounted vacuum chamber with a vacuum of 28 Torr applied for eight hours. Following vacuum treatment, the heart was allowed remain in the silicone solution at ambient pressure within the freezer for an additional 16 hours. The following day, this process was repeated using the same silicone oil. After this second eight hour period of bulking, the heart was removed from the freezer and placed onto a metal grid for thirty minutes so that all free-flowing silicone oils could drain from the heart. During this period, excess pools of silicone oil were removed from the surface of the organ by gently wiping the pooled areas with a lint-free cloth.

As in many of our other experiments, the heart was then placed into a warming oven, pre-heated to 110 degrees Fahrenheit. To contain the catalyst fumes needed for the polymerization process, a containment chamber consisting of an inverted polyethylene bucket with lid was placed into the warming oven to act as a sealed container for the heart. The heart itself was placed on lint-free cloths on top of a mesh screen that was placed on top of a flat dish containing two ounces of CT-32 catalyst. With the containment chamber sealed, the warming oven was closed and the heart was exposed to the warmed catalyst fumes for twenty-four hours. After this initial period, it was noted that the catalyst had began to harden so it was replaced with a new tray containing fresh catalyst. After eight hours of treatment with this new catalyst, the heart appeared glossy and slightly tacky to the touch. At this point, the heart was removed from the oven and immediately placed back into the plastic container of silicone oil that had been used during its initial bulking. Prior to placing the heart back in the silicone however, one half ounce of CT-32 had been gently folded into the PR-10 oil so that bubbles would be kept to a minimum. After allowing the heart to sit in this solution for three hours at ambient room temperature and pressure, the heart was removed and its surfaces were gently wiped to remove excess oils. The heart was then placed back into the oven and exposed to catalyst fumes over night. The heart was then removed from the oven and allowed to remain in fresh air for several hours.

A. Warming Oven
B. Containment Chamber
C. Heart
D. Mesh Support Screen
E. Dish with Catalyst

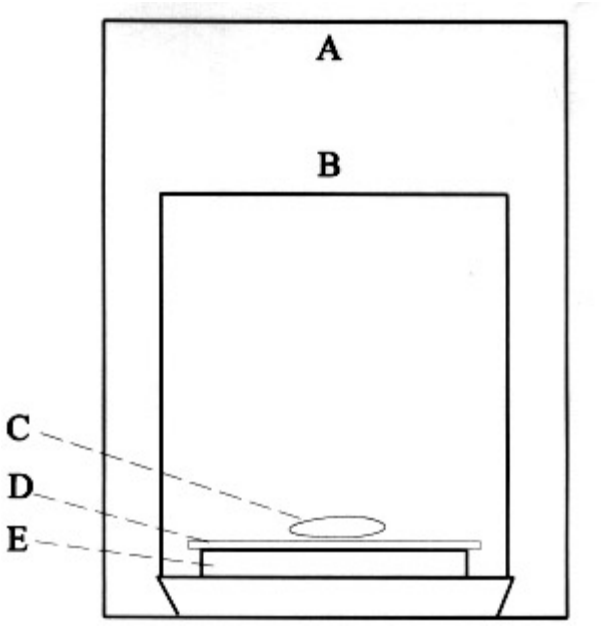

Figure1. Set-up for polymerizing the dog heart.

After three hours, the heart was dry to the touch and no odor of catalyst was noted. Slight surface pooling had occurred resulting in a glossy appearance of small areas around the major arteries owning to inadequate surface wiping.

Observations

Because the removal of lipids is a primary factor in the successful preservation of tissues, thiourea and photo-flo were added during the second alcohol dehydration bath in the hopes that they would decrease the surface tension of water and lipids within the tissues, enabling more lipids and impurities to be flushed out. After sitting for twenty-four hours, it was noted that the coloration of the heart was more uniform and that many of the surface veins of the heart appeared to be cleaned of blood. When the alcohol solution was poured off, more lipids and blood were present than had been observed after the first dehydration bath.

Because the addition of thiourea and photo-flo appeared to have some positive effects during initial stages of alcohol dehydration, these chemicals were added to the third bath of acetone in the hope that along with vacuum displacement, their presence might remove additional lipids from the organ. After the final acetone treatment, however; the acetone was very clear, suggesting that much of the lipids had been removed from the tissues. After dehydration, the color of the heart was considerably lighter than its pre-treatment state, suggesting that the organ was ready for bulking with silicone oils.

From our experience, sixteen hours of bulking using a freezer-mounted vacuum system should be sufficient to displace and replace acetone within the cellular structure and voids of heart tissues. Inspection of the nearly completed heart however suggested that while bulking had been successful, a heavier surface coating to consolidate the surfaces of the

organ. This meant sacrificing a small quantity of PR-10 silicone oil which could have been re-used, for better results. Reasoning that the tissues of the heart were heavily laden with active catalyst fumes when it was removed from the warming oven, this final immersion in silicone oil was intended to react with these fumes as well as the small amount of catalyst that had been added prior to immersion, to form a quickly consolidated outer surface.

Conclusions

As in many conservation strategies, the conservator should consider both consolidation and preservation strategies that best preserve the diagnostic features of the material being conserved. The appearance of the exterior surface of the heart during the final stages of polymerization looked as though it might be slightly dry, suggesting that too much silicone had been wiped from its surface prior to catalyst fume exposure. In future experiments, a thicker layer of silicone oil should be left on the heart, realizing that during the polymerization process, excess oils will drain from the organ and that the catalyst will have to be replaced more frequently.

In spite of an effort to minimize impressions being made on the surface of the organ due to its resting on cloth covered mesh during the polymerization process, a number of mesh marks were noted on the finished specimen. Lint free cloths are inexpensive and either a thicker bed of these materials is needed to cushion the organ during the polymerization process or a flatter surface is needed to prevent impressions on the organ surface. In either case. The organ should be rotated periodically during this phase of treatment to prevent an unnatural flattening or mis-shaping of the organ.

Silicone bulking appears to be a viable and cost effective means of preserving major organs and tissues for necropsy and biological study. The actual time elapsed during the conservation of this specimen was eight and one-half days, including the final steps of surface consolidation. Undoubtedly, the time required to successfully conserve an organ similar in size to this one could be drastically reduced if the bulking processes were continuous and not stopped when the apparatus was not under direct supervision.

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