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Ultrastructure of Human Tissues After Prolonged Interment in Metal-Lined Coffins

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ABSTRACT: The ultrastructure of certain tissues is sometimes preserved after lengthy interment in metal-lined coffins. Susceptible structures of the epidermis, such as the mitochondria and nuclear envelopes, may be clearly identifiable. Electron microscopy thus permits recognition not only of individual cell types, but also of different intracytoplasmic organelles. In the same way, striped muscle fibers are well preserved, and all components of sarcomeres may be distinguished.

KEYWORDS: pathology and biology, tissues (biology), microscopy, putrefaction, postmortem changes

Dehydration in a hot, dry environment leading to mummification [*1,2*] and saponification [*3-5*] with formation of adipocere are two well-known alternatives to putrefaction. A third form of postmortem change that may result in preservation of tissue architecture is called *corification* (from Latin *corium*, leather). Dalla Volta [*6*] was the first to describe this change [*7-13*]. The condition of corification occurs quite frequently when zinc- or lead-lined coffins are used. In bodies wherein corification has occurred, the skin resembles tanned leather and is quite elastic, the viscera are shrunken, and microscopic recognition of normal and pathological tissue is possible. Ultrastructural studies in the field of postmortem preservation have so far been confined to mummification [*1*]. This paper describes our findings with the ultrastructural technique in all three types of postmortem change.

The ultrastructural appearance of cells from all layers is well preserved in "corified" skin. The cell membranes can be clearly distinguished (Fig. 1a), as can their adhesion sites (Figs. 2a,b), cytoskeleton, and perinuclear areas. Both free and membrane-bound ribosomes can be observed (Fig. 1b). The mitochondria and reticulum are still identifiable, though less well preserved. The intercellular spaces are unusually wide and contain amorphous material.

Skeletal muscle is astonishingly distinct (Fig. 3a). All typical features of sarcomeres, such as the appearance of myofilaments, can be distinguished (Fig. 3c). The spaces between myofibrils are larger than in wet muscle. Mitochondria and reticulum residues can often be seen (Fig. 3b).

Parenchymatous organs, however, are profoundly altered and only their stroma remains. In the kidney, tubular epithelium has completely disappeared, while the edges of the tubules are marked by a uniformly dense band of amorphous material, probably derived from basal

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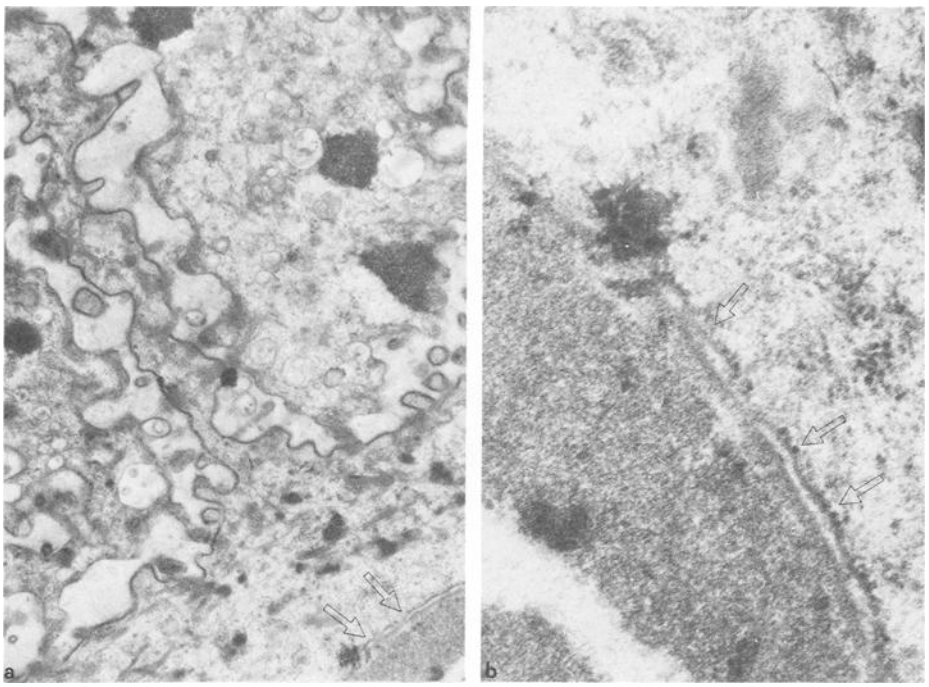

FIG. 1—*Skin of corified body seven months after death. Stratum lucidum. Nucleus and envelope, with ribosomes* (arrows). *Detail of* a *at higher magnification in* b.

lamina. Nests of collagen fibrils can be seen among tubule ghosts, as can several myelinic bodies in the lumen.

Blood vessels are well preserved, and substantially unaltered red cells are sometimes seen.

Even though saponified tissues are highly altered, as to be virtually indistinguishable, collagen fibers of skeletal muscle are well preserved while muscle fibers themselves have entirely lost their ultrastructural characteristics.

The myelin sheath of peripheral nerves is particularly well preserved (Figs. 4 a and b). The axon structure, however, has almost entirely disappeared and has been replaced by unidentifiable material.

In mummification, our findings on recent material are similar to those described for archaeological remains. The skin epithelial cells are profoundly altered, though the membranes and nuclei can still be distinguished. We have not come across instances of satisfactory mummification of muscles and viscera.

It would seem that the gross appearance of a preserved body corresponds to a typical morphological and ultrastructural picture. In the case of mummification and saponification, however, good preservation is not matched by a clear ultrastructural picture. Saponification is worse in this respect, since tissues are not really preserved but are converted into amorphous adipocere. Myelin sheaths and collagen fibers are exceptions, probably on account of their nature and molecular organization. In mummification, dehydration results in a coarse ultrastructure. Organelles and membranes can be identified, though with some difficulty. By contrast, the preservation of delicate organelles in a corified body is so good that the "microclimate" set up by the metal lining, coupled perhaps with a direct action of zinc on tissues, might not only impede putrefaction but also delay autolysis.

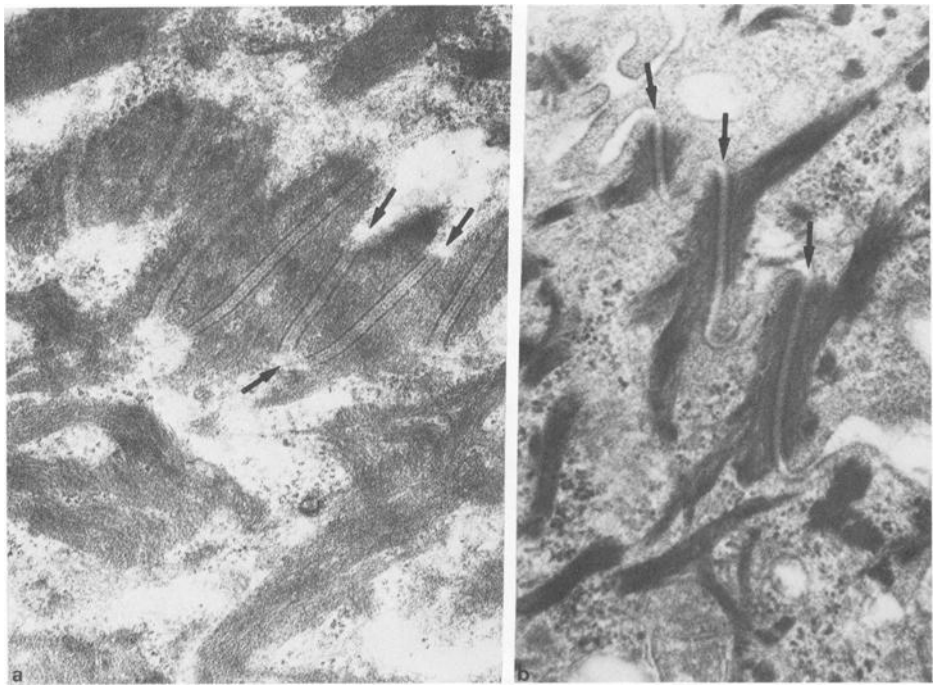

FIG. 2—*Skin of corified body 7 months* (a) *and 18 months* (b) *after death. Stratum spinosum. Desmosomes* (arrows) *and tonofibril.*

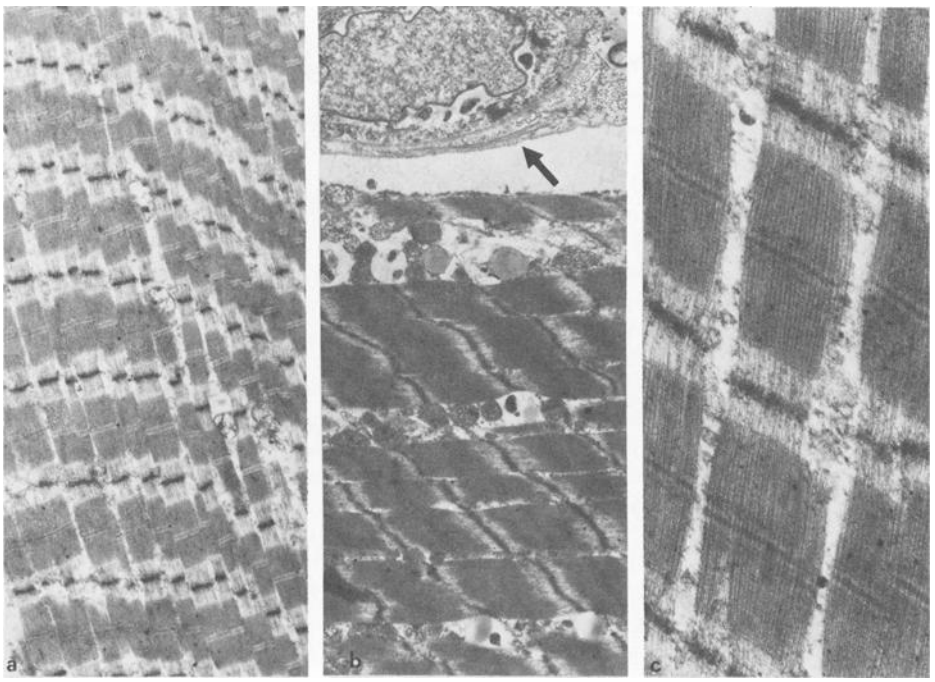

FIG. 3—*Skeletal muscle of corified bodies 7 to 18 months after death. Regular arrangements of myofibrils* (a, b) *and absence of sarcomere impairment* (c). *Note the fibroblast in* b (arrow).

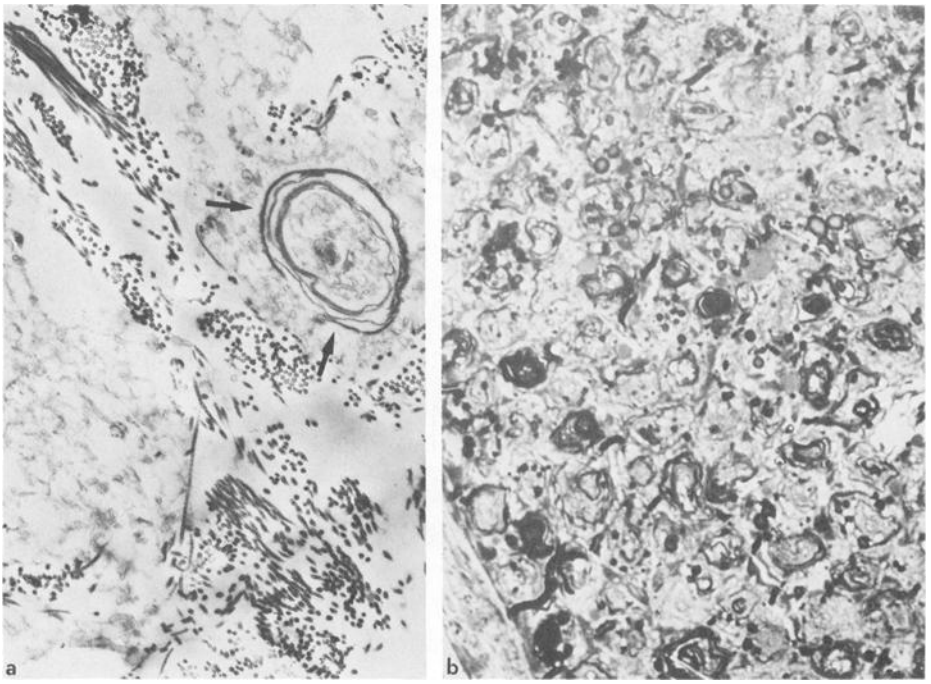

FIG. 4—*Adipocere transformation in a body found two years after death (in a pre-Alpine lake). Left femoral nerve. Only the collagen fibers and myelin sheaths* (arrows) *are preserved. Corresponding thick section in* b.

Acknowledgments

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