

Introduction

In medicine, the use of embalmed bodies is essential for studying anatomy and for training (new) surgical skills. Almost all embalming fluids worldwide in use contain formalin and phenol (Benkhadra et al. 2011), of which formalin is responsible for fixation and phenol for preservation of the cadaver.

Fixation with standard concentrations of formaldehyde (4%) hardens the tissue and severely decreases the flexibility of tissues and joints. Due to its high reactivity, phenol seems to have a negative effect on tissue colour differentiation. Both are hazardous substances which conditions of use and disposal routes are strictly regulated (Toxnet - US National Library of Medicine, <http://toxnet.nlm.nih.gov>).

As the anatomical community is more aware of the occupational risks involved and of the high costs to reduce levels of exposure, the interest for low-hazardous alternatives grows. Furthermore, in surgical training there is a growing demand for embalmed cadavers with life-like morphology as a safer and more durable alternative for fresh (frozen) cadavers.

Project aims

The Fix for Life project aims to develop a low-hazardous embalming method preserving life-like morphology. To achieve this the following criteria should be met:

- Low-hazardous composition
- Reduction of formaldehyde
- Exclusion of phenol
- Good fixation
- Broad spectrum antimicrobial efficacy
- Life-like morphology
- Suitable for dissection and surgical (endoscopic / minimally invasive) techniques

Materials and methods

The methodology and choice of materials is based on a pilot study by Cleypool (2010):

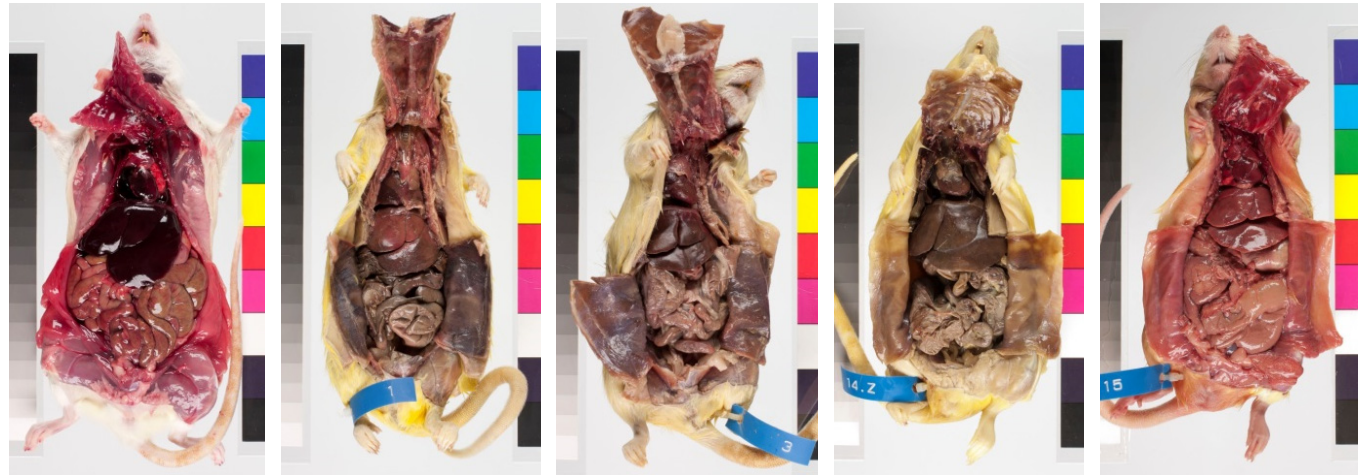
- Surplus rats (4-24 hours post mortem)
- Control: fresh frozen rat
- For comparison, 2 rats are embalmed according to the standard procedures of the Academic Medical Centre, Amsterdam (AMC) and the Leiden University Medical Centre (LUMC)
- 15 experimental embalming recipes/methods
- Perfusion by pump or drip bottle through the carotid artery (1-4 hours)
- Storage in plastic bags with wetting agent and/or by immersion in glass containers
- After 2-3 months the morphological properties (consistency, colour, flexibility and suitability for dissection and/or surgical techniques) of the rats are rated by an expert panel.

Conclusions

The newly developed and experimentally tested "Fix for Life" method can provide in well preserved cadavers with life-like morphology for education and training uses in medicine over a prolonged period of time without the risk of exposure to pathogens when using fresh (frozen) cadavers or to toxic levels of formaldehyde and phenol when applying conventional embalming methods.

Results

Images of partially dissected rats (2-3 months post mortem) reviewed by the expert panel (max. score range 0-10).



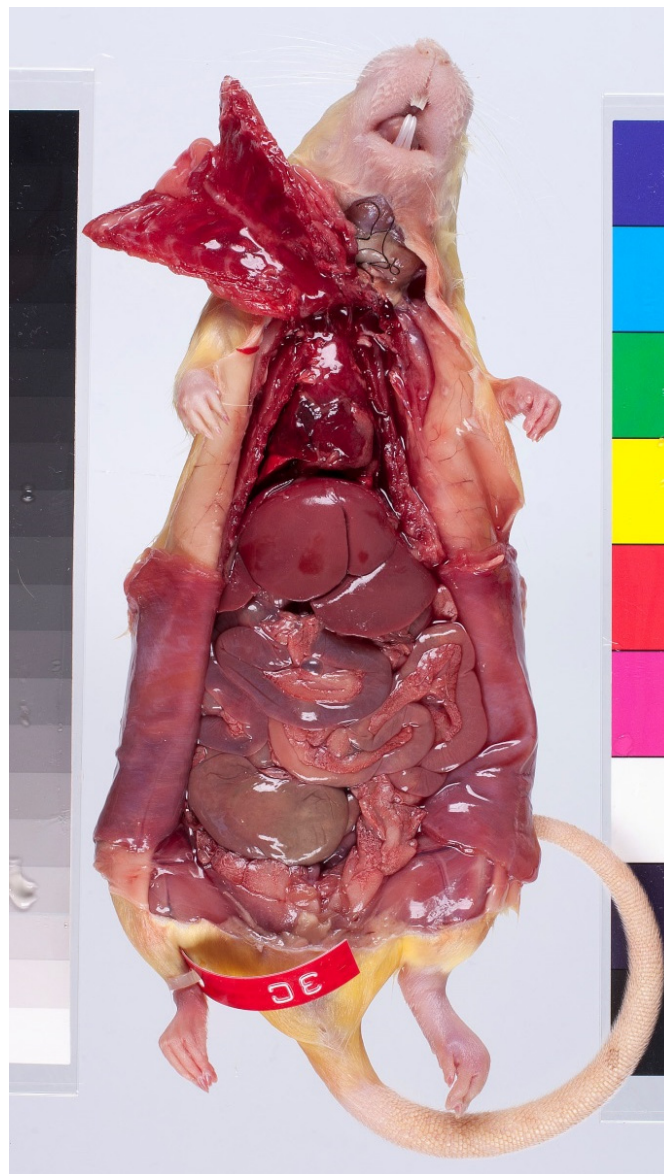
Control:
Fresh frozen
Panel score 7.0

AMC standard
embalming procedure
Panel score 6.2

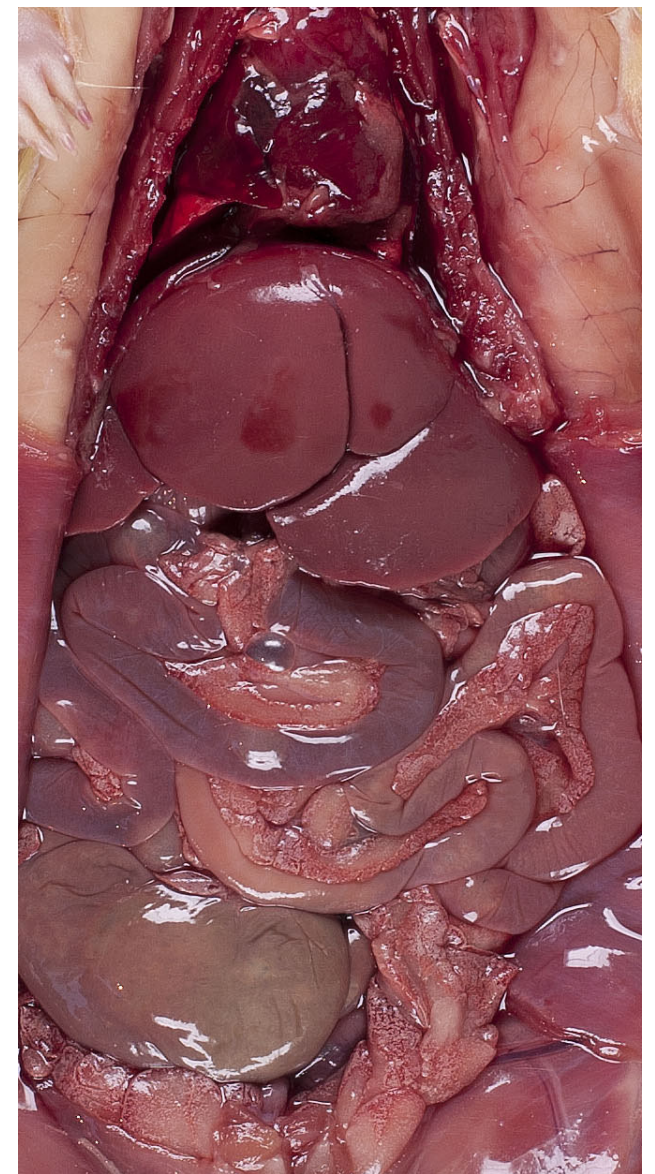
LUMC standard
embalming procedure
Panel score 7.3

Experimental procedure
resulting in lowest panel
score of 2.3

Experimental procedure
resulting in highest panel
score of 8.3



Latest advanced experiment shows excellent life-like morphology (one month post mortem). The applied embalming composition is phenol-free and the formaldehyde concentration has been reduced by 75% (compared to standard LUMC method).



References

- Benkhadra, M. et al. 2011. *Is Thiel's embalming method widely known? A world survey about its use.* Surg. Radiol. Anat. 33:359-363
- Cleypool, C.G.J. 2010. *The Applicability of "Whole Body Preservation Techniques" in Biomedical Science. A pilot study.* Master's thesis Biomedical Science, University of Amsterdam / Academic Medical Centre. 66 pp.

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