



SCHOOL OF MEDICINE
Anesthesiology

Safe and Sustainable: Newer Cadaver Preservation for Future Anesthesia Training

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Introduction

With the growing field of regional anesthesiology requiring anatomic expertise and ultrasound precision, cadaver education has the potential to be a stalwart for learning.

Formaldehyde-based preservation methods are commonly utilized, along with phenol-based and fresh-frozen methods.

- **A newer embalming solution, referred to as Green, preserves the colors, textures, and pliability of the body tissues, and provides long term preservation of cadavers.**
- Green techniques also are potentially less toxic than formaldehyde, which is a known carcinogen.
- The non-toxic and alive-like properties of these cadavers **could prove beneficial in training for regional anesthesiology** by providing more realistic conditions for ultrasound-guided nerve blocks.

We set out to **compare the realistic qualities of the Green cadaver and traditional cadaver when performing peripheral nerve blocks.**

References :

(1) Brenner E. Human body preservation - old and new techniques. J Anat. 2014 Mar;224(3):316-44. doi: 10.1111/joa.12160. Epub 2014 Jan 18. PMID: 24438435; PMCID: PMC3931544.

(2) Nontoxic Tissue Preservation. Green Solutions Group. (2024, April 4). <https://gogreensolutionsgroup.com/>

(3) Benkhadra M, Faust A, Ladoire S, Trost O, Trouilloud P, Girard C, Anderhuber F, Feigl G. Comparison of fresh and Thiel's embalmed cadavers according to the suitability for ultrasound-guided regional anesthesia of the cervical region. Surg Radiol Anat. 2009 Aug;31(7):531-5. doi: 10.1007/s00276-009-0477-z. Epub 2009 Feb 19. PMID: 19225711.

(4) Munirama S, Satapathy AR, Schwab A, Eisma R, Corner GA, Cochran S, Soames R, McLeod GA. Translation of sonoelastography from Thiel cadaver to patients for peripheral nerve blocks. Anaesthesia. 2012 Jul;67(7):721-8. doi: 10.1111/j.1365-2044.2012.07086.x. Epub 2012 Apr 16. PMID: 22506553.

(5) Munirama S, Eisma R, Columb M, Corner GA, McLeod GA. Physical properties and functional alignment of soft-embalmed Thiel human cadaver when used as a simulator for ultrasound-guided regional anaesthesia. Br J Anaesth. 2016 May;116(5):699-707. doi: 10.1093/bja/aev548. PMID: 27106974.

Methods

- An **8-item questionnaire** was developed to compare each cadaver to a live human.
- This questionnaire was developed based upon literature review and Inter-rater reliability.
- **Ten regional anesthesiologist evaluators** completed the questionnaire.
- Each rater performed ultrasound guided perineural injections
- Each question was answered via a rating on a **Likert scale from 1 to 10**. The gold standard (score of 10) is what one would expect on a live patient.
- **Two cadavers were studied, one preserved by the traditional formaldehyde formulation, while the other preserved in the Green (GreenMBalm® (Green Solutions, Burlington, NC)) method**
- Responses to each question were compared to each other via the Kruskal-Wallis Rank Sum Test.
- An interclass correlation coefficient was also calculated to test inter-rater reliability

Summary: Raters found the experience of performing ultrasound-guided nerve blocks on the Green cadaver closer a live human compared to the traditionally embalmed cadaver.

Results

The **Green cadaver scored higher on all eight questions** per evaluator mean and median scores. Statistically significant differences were detected for 7/8 questions. Needle Visualization did not show a significant difference. **An interclass correlation coefficient greater than 0.6 was calculated, showing moderate reliability amongst raters.**

Question	Mean Traditional Rating	Mean Green Rating	Median Traditional Rating	Median Green Rating	Standard Deviation (Overall)	P-Value
Anatomy Visualization	6.1	8.2	6.5	8	1.87	.014
Needle Visualization	8.9	9.4	9.5	10	1.18	0.346
Tactile Feedback	4.3	7.7	4	8	2.60	0.00291
Local Anesthetic Spread	5.3	8.1	5.5	8.5	2.41	0.00552
Tissue Pliability	2	7.7	2	8	3.15	<0.0001
Skin Resistance	3.7	7.5	3	7.5	2.58	0.00105
Preservation Irritation	2.9	5.5	2	5	3.04	0.0375
Overall Realism	4.4	7.8	5	8	1.97	<0.0001

Discussion

The **Green cadaver appears to provide more realistic conditions for regional nerve block procedures than the traditional preservation method.** Overall, raters found the experience of performing ultrasound-guided nerve blocks on the Green cadaver **closer a live human**. In addition to providing **better conditions for peripheral nerve block training**, green cadavers may be **less toxic** than formaldehyde preserved cadavers.

