



An Economic Alternative to Traditional Bone Cleaning Methods in Preserved Cadavers



Introduction

Human osteological material is an essential part of research, education, physical, and 3D collections; however, attaining osteological samples can be expensive and time consuming. Cadavers from anatomical courses are a resource for osteological material. This resource requires cleaning and preparing the bones for educational or research settings. Several methods for removing soft tissue from bones in non-embalmed cadavers have been published, including laundry detergent, enzymatic maceration, insect consumption, and manual removal. These methods vary in cost effectiveness, time consumption, and health hazards.

The most effective methods for cleaning bones from embalmed cadavers have not been adequately described. This study tested the efficacy of using detergent to clean bones from embalmed cadavers. Of the common bone cleaning methods in the literature, detergent poses few health hazards, is low cost, easy to acquire, and easy to dispose of.

Methods

32 human cadaver tali and calcanei from the Willed Body Program at Texas A&M University were cleaned following 8 bone cleaning techniques: Plain water bath and boil, Ariel detergent water bath and boil, Tide + bleach water bath and boil, Dawn dish soap boil, and Alconox Multipurpose Cleaner boil. All water bath trials were evaluated after 1, 2, and 3 days, while boil trials were boiled at 100 C°, then evaluated after 2.5, 4.5, and 6 hours. All solutions were crafted with 50 ml of cleaner product per liter of water.

A scoring system evaluated each trial for ease of soft tissue removal, duration, cost, and odor. The scoring system ranged from 1 to 3, with one being the least effective, and 3 being the most effective. A higher score would indicate a more efficient method of bone cleaning.

Table 1 Maceration scoring system

Ease of soft tissue removal	
1.	Soft tissue is firm and solid. Difficult to remove without cutting and scraping materials
2.	Soft tissue is soft and loose. Difficult to remove without cutting and scraping materials
3.	Soft tissue is soft and loose. Tissue is easy to remove without cutting and scraping materials
Duration	
1.	Over 24 hours
2.	6-24 hours
3.	0-6 hours
Cost	
1.	\$25 and above
2.	\$5-\$24.99
3.	\$0-\$4.99
Odor	
1.	Strong unpleasant odor present outside of the immediate workspace
2.	Moderate unpleasant odor in the vicinity of the workspace
3.	Little to no unpleasant odor in the immediate vicinity of the workspace

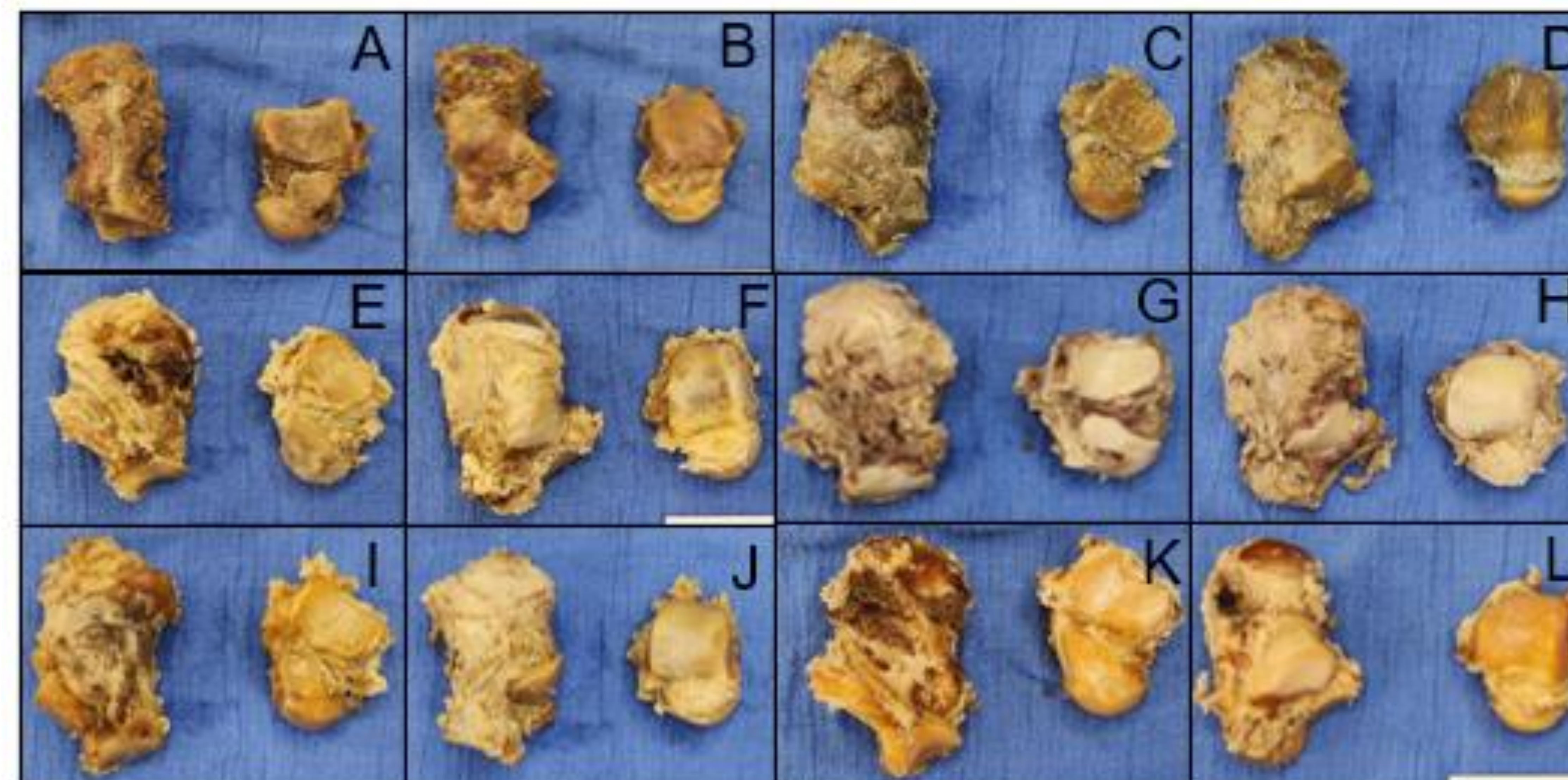
Results

Tide + bleach detergent resulted with the highest score of 11, while all water bath trials received the lowest scores of 7 and 8. 12 was the highest score attainable. All water bath trials maintained heavy amounts of soft tissue at the end of the three-day maceration period, resulting in low scores in both ease of soft tissue removal and duration. For the boil trials, only Tide + bleach had removed the majority of the soft tissue from the bones, and received the highest score in both categories of duration and ease of soft tissue removal.

Alconox multipurpose cleaner received the lowest score for cost, while tap water maceration received the highest score. None of the trials harbored any negative smells, while the detergent trials emitted pleasant scents, earning all trials a 3 in this category.

Table 2 Maceration trial scores

Trial	Ease of soft tissue removal	Duration	Cost	Odor	Total Score
Water bath	1	1	3	3	8
Water boil	1	1	3	3	8
Ariel detergent water bath	1	1	2	3	7
Ariel detergent boil	2	2	2	3	9
Tide + Bleach water bath	1	1	2	3	7
Tide + Bleach boil	3	3	2	3	11
Dawn dish soap boil	1	2	3	3	9
Alconox Multipurpose Cleaner boil	2	2	1	3	8



Talus and calcaneus tarsal bones from the donors of the Texas A&M School of Medicine Willed Body Program. A) Inferior view: Tide plus Bleach detergent formula; Boil time 2.5 hours B) Superior view: Tide plus Bleach detergent formula; Boil time 2.5 hours C) Inferior view: Ariel detergent formula; Boil time 2.5 hours D) Superior view: Ariel detergent formula; Boil time 2.5 hours E) Inferior view: Dawn dish soap formula; Boil time 2.5 hours F) Superior view: Dawn dish soap formula; Boil time 2.5 hours G) Inferior view: Ariel detergent water bath H) Superior view: Ariel detergent water bath I) Inferior view: Plain water boil; Boil time 6 hours J) Superior view: Plain water; boil time 6 hours K) Inferior view: Alconox multipurpose cleaner formula; boil time 2.5 hours L) Superior view: Alconox multipurpose cleaner formula; boil time 2.5 hours

Summary

Results of the scoring system indicate the Tide + Bleach boil was the only solution in our study to effectively clean dense tissue from these embalmed irregular shaped bones in under 6 hours. This technique minimizes investigator health and safety risks inherent in other maceration techniques. Additionally, access to detergent is attainable in most regions of the world, whereas alternative methods, including chemical enzymes and insects, may be difficult to access or maintain in some settings.

Conclusion

This study demonstrates a technique that is simple to execute where embalmed cadaver bones may need to be cleaned, catalogued, or digitized. This bone cleaning method can be utilized quickly and cost efficiently, with minimal health risks, for a multitude of educational or research purposes. Future research may test the efficacy of alternative methods of maceration, such as enzymatic maceration, insect consumption, and other techniques for cleaning embalmed cadaver bones. Additionally, future research should compare the bone cleaning efficacy of alternative detergent brands, as well as detergent types. Limited research has been conducted comparing liquid, powder, and pod forms of detergent for use in cleaning preserved and natural cadaver bones.

Digital learning is becoming more commonplace and vital as access to natural material is not always available or guaranteed. Multiple entities could benefit from cost effective and fast bone cleaning procedures, including institutions looking to increase osteological sample sizes for physical or digital database collections.

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