28 DAYS LATER: DNA RECOVERY FROM CHEMICALLY TREATED HUMAN REMAINS

Jennifer Snedeker, BS; Rachel Houston, PhD; Sheree Hughes, PhD

Department of Forensic Science, Sam Houston State University, Huntsville, TX 77340

INTRODUCTION

Identifying human remains has always been a complex task, but as offenders develop new methods for disposal, it has become even more challenging. In some violent criminal cases, offenders go to extraordinary lengths to destroy incriminating evidence, such as dissolving victims in common household chemicals. While such practices were once mainly associated with large criminal organizations, their prevalence has increased due to the influence of popular television shows like 'Breaking Bad.'

Despite the growing frequency of such cases, there is limited research on DNA recovery from human remains treated with aggressive chemicals. Most studies focus on the visual effects these chemicals have on tissues [1, 2]. The few studies that examine DNA recovery rely on animal proxies or focus solely on DNA recovery from human teeth, leaving a gap in research using realistic samples [3–6]. Our study addresses this issue by recreating the most authentic case scenarios, exposing intact segments of human cadavers to readily accessible household chemicals available at local hardware stores.

MATERIALS & METHODS

- **Sample Treatment:**
  - Head, forearms, and hands were collected from five cadavers at the Southeast Texas Applied Forensic Science (STAFS) Facility
    - Treated up to 28 days in either bleach, Rid-X® septic treatment, lye drain cleaner, sulfuric acid drain opener, or hydrochloric acid pool cleaner
  - Samples (bone, teeth, tissue, hair, fingers/fingernails) were collected on days 0, 1, 3, 5, 7, and 28 (21 for sulfuric acid)
- **DNA Extraction:**
  - Bone and Teeth – Adaptation of Loreille et al. total demineralization [7]
  - Tissue, Hair, and Nails – EZ2® DNA Investigator Trace Protocol (QIAGEN)
- **Quantification:** Investigator® Quantiplex® Pro (QIAGEN)
- **Traditional STR Analysis:** Investigator® 24plex QS (QIAGEN)
- **Mitochondrial DNA Analysis:** [Small Target] ≤ 2 pg/µL
  - HVI & HVII region – mini primers
  - BigDye® Direct Cycle Sequencing Kit (Thermo Fisher Scientific)
  - BigDye® Xterminator Purification Kit (Thermo Fisher Scientific)

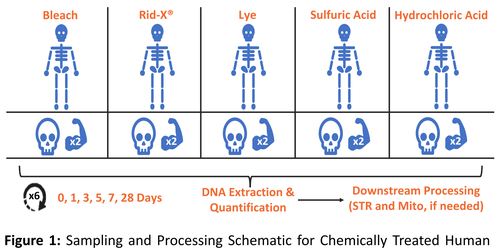

Figure 1: Sampling and Processing Schematic for Chemically Treated Human Remains

RESULTS & DISCUSSION

Bleach

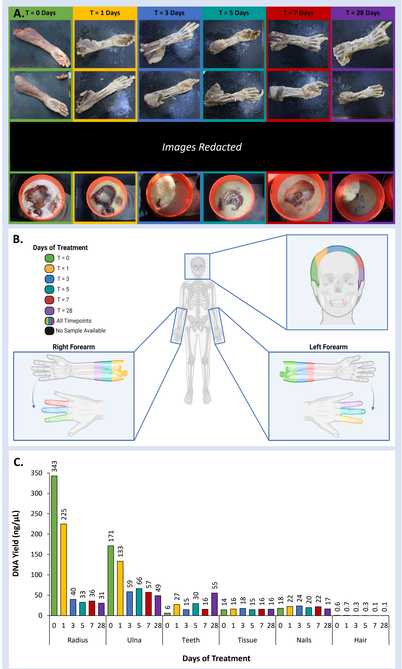

Figure 2: Bleach Treatment – A.) Progression of damage throughout treatment **B.)** Samples collected throughout treatment **C.)** DNA yield of collected samples

- Discoloration, tissue damage, and minimal bone exposure
- Damage stalled after day 1
- Sample integrity remained throughout treatment
- 100% allele recovery for all bleach treated samples at all time points

Rid-X®

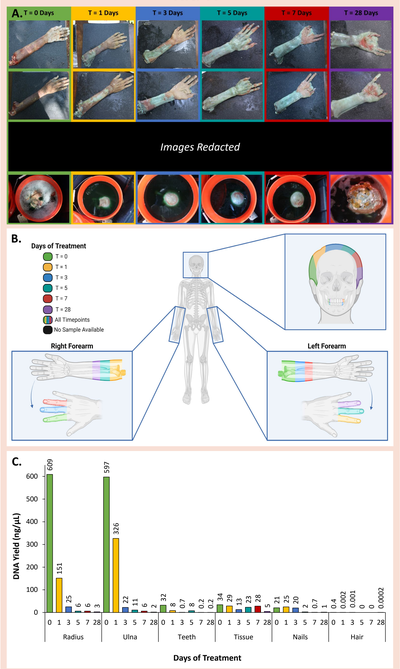

Figure 3: Rid-X® Treatment – A.) Progression of damage throughout treatment **B.)** Samples collected throughout treatment **C.)** DNA yield of collected samples

- Discoloration, gelatinous tissue
- Sample integrity remained throughout treatment
- Reduced DNA recovery over treatment length – environment conducive for decomposition
- 100% allele recovery for all Rid-X® treated samples at all time points **except hair**
- MtDNA analysis of hair – full coverage of HVI & HVII

Lye

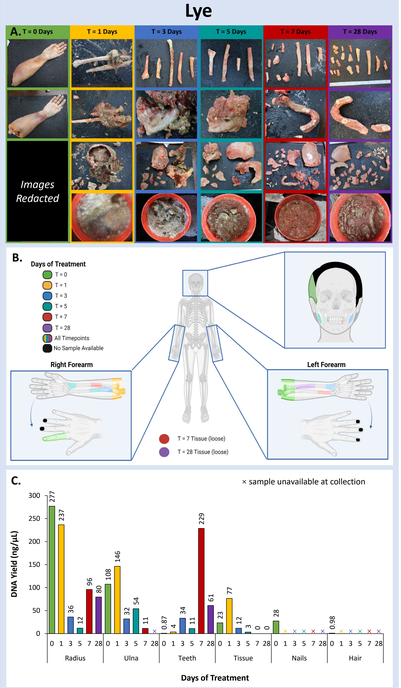

Figure 4: Lye Treatment – A.) Progression of damage throughout treatment **B.)** Samples collected throughout treatment **C.)** DNA yield of collected samples

- Exothermic reaction: ≥ 70◦C
- Tissue and bone damage; nails and hair dissolved by day 1
- Saponification and loss of sample integrity
- 100% allele recovery for all skeletal samples (bone & tooth) at all time points
- MtDNA analysis unsuccessful on tissue collected at days 7 & 28

Sulfuric Acid

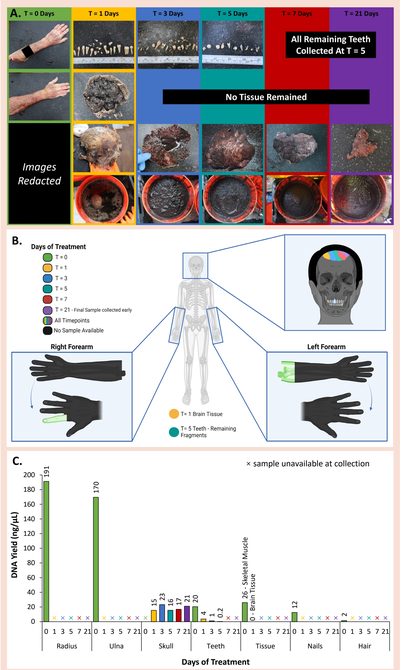

Figure 5: Sulfuric Acid Treatment – A.) Progression of damage throughout treatment **B.)** Samples collected throughout treatment **C.)** DNA yield of collected samples

- Exothermic reaction: ≥ 60◦C
- Accelerated damage: complete dissolution of forearms; skull fragments recovered at day 1
- Final sample pulled early at day 21
- 100% allele recovery for all skeletal samples at all time points
- MtDNA analysis unsuccessful on tissue collected after exposure

Hydrochloric Acid

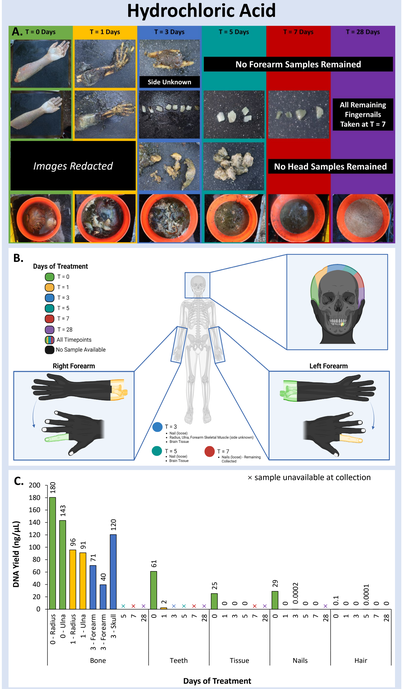

Figure 6: Hydrochloric Acid Treatment – A.) Progression of damage throughout treatment **B.)** Samples collected throughout treatment **C.)** DNA yield of collected samples

- Most damaging chemical to DNA recovery with identifications only possible up to 3 days of exposure
- Identifications only possible through skeletal samples
- Although hair and nails survived longer than all other tissues, mtDNA analysis was unsuccessful

CONCLUSIONS

1. Human identification of remains treated with everyday household cleaners is possible
   - **Bleach, Rid-X®, Lye:** Identifiable after 28 days of exposure
   - **Sulfuric Acid:** Identifiable after 21 days of exposure
   - **Hydrochloric Acid:** Identifiable after 3 days of exposure
     - Most damaging chemical to DNA recovery
2. Skeletal elements (bone & tooth) provided full allele recovery when recovered from chemical treatment
3. Each chemical had its own distinct appearance and effect on human tissue allowing for potential identification of the chemical agent

REFERENCES

1. K.M. Hartnett, L.C. Fulginiti, F. Di Modica, The effects of corrosive substances on human bone, teeth, hair, nails, and soft tissue, J. Forensic Sci. 56 (2011) 954–959.
2. D.J. Cope, T.L. Dupras, The effects of household corrosive chemicals on human dentition, J. Forensic Sci. 54 (2009) 1238–1246.
3. M. Al-Owaidi, M.N. Al-Terehi, A.H. Al-Saadi, K. Zibara, Forensic STR identification of human teeth samples exposed to various acidic and alkaline chemical conditions in the Iraqi population, Syst Rev Pharm 11 (2020) 352–359.
4. O.O. Iroanya, J.O. Ogbeide, T.F. Egwuatu, The integrity of dna extracted from Oryctolagus cuniculus carcasses treated with different corrosive chemical substances, Sci. J. Univ. Zakho 8 (2020) 42–47.
5. C. Robino, M. Pazzi, G. Di Vella, D. Martinelli, L. Mazzola, U. Ricci, R. Testi, M. Vincenti, Evaluation of DNA typing as a positive identification method for soft and hard tissues immersed in strong acids, Leg. Med. 17 (2015) 569–575.
6. N.P. Damascena, M. de V.C. SANTOS-FILHO, G.R.B. de Souza, L.A.F. da Silva, C. dos S. Estevam, A. Franco, L.R. Paranhos, J. de O. Musse, Testing the extraction of DNA from human teeth exposed to different chemical solutions, Int J Odontostomat 11 (2017) 173–177.
7. O.M. Loreille, T.M. Diegoli, J.A. Irwin, M.D. Coble, T.J. Parsons, High efficiency DNA extraction from bone by total demineralization, Forensic Sci. Int. Genet. 1 (2007) 191–195. https://doi.org/10.1016/j.fsigen.2007.02.006.

ACKNOWLEDGEMENTS

Disclaimer: This project was partially funded by the Forensic Science Foundation Lucas Grant. The opinions, finding, conclusions, or recommendations expressed in this presentation are those of the authors.

Thank you to the STAFS Facility (a willed body donor program at Sam Houston State University), the donors, and their loved ones, without whom this research would not be possible.