A20 Best Practices for Macerating Cartilage

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Learning Overview: After attending this presentation, attendees will understand the need to adopt minimally destructive and easily available methods for removing extraneous soft tissue from thyroid cartilage, which is frequently damaged by tools or harsh methods during the macerating process.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing useful, realistic, and minimally destructive methods for the removal of soft tissue from cartilage, identified via the use of store-bought raw pig ears as proxies for human tissue.

The thyroid cartilage is the uppermost cartilage in the human larynx, serving the purpose of supporting and protecting the vocal cords, as well as providing an attachment site for laryngeal muscles and the hyoid bone via the thyrohyoid membrane. In forensic contexts, visible abnormalities on the thyroid cartilage may be indicative of trauma, especially in forensic cases involving asphyxiation. The thyroid cartilage may bear ligature marks, broken superior horns, or even scratches. These can aid in determining the cause and/or manner of death.[1] Similarly, the position of ligature marks on the thyroid cartilage may distinguish between a suicide by hanging or homicidal strangulation. The thyroid cartilage must be cleaned and free of surrounding soft tissue before these marks can be clearly observed.

While much has been written in the literature about processing bones, little information exists about a proper way to process the thyroid cartilage. While cool water maceration will remove extraneous soft tissue from the cartilage, this method often takes weeks to months. Manual removal of soft tissue is a much faster process; however, it requires the use of tools, which may result in inadvertent cut marks.

The study described here tested several methods to process cartilage from 40 pig ear portions. Pig ears were chosen as a proxy for human thyroid cartilage because they are approximately the same thickness as human thyroid cartilage and are readily available at supermarkets. Unlike thyroid cartilage, which is a firm hyaline cartilage, pig ears are composed of a slightly more malleable elastic cartilage. However, both hyaline and elastic cartilage are composed of type II collagen and possess perichondrium, making them similar enough to use for the purpose of this experiment. The pig ears were quartered and cut to mimic the average dimensions of a thyroid cartilage. Ears were first subjected to sharp force trauma with a scalpel, producing cuts 3cm in length without completely penetrating the cartilage, before processing to determine if the processing method damaged the cartilage or cut mark in any observable fashion.

Four processing methods were utilized. These methods included: (1) dermestid beetles; (2) cold water maceration; (3) heat maceration; and (4) chemical maceration with 300mL solutions of (a) laundry detergent, (b) sodium borate, (c) bleach, (d) multi-purpose cleaner, (e) meat tenderizer, (f) papain, and (g) hydrogen peroxide. Four portions of pig ears were used to test each processing method.

A 19-point scoring system adapted from Steadman and colleagues was used to test the efficacy of the maceration methods.[2] The scores are based on odor (0-3), soft tissue texture (0-3), ease of soft tissue removal (0-5), cartilage quality (0-5), and duration (0-3). For each item in the scoring system, a higher number indicates best-case scenario (i.e., a method scoring a 3 for odor will have generated little to no odor). Methods receiving a higher point score are deemed better because they do well in multiple categories.

With a final score of 18/19, a solution of 1tsp of sodium borate to 300mL water at 150°F for two hours was found to be the best method for removing the surrounding tissue from pig ear cartilage, as it was quick, cost effective, and required no processing tools for soft tissue removal. In contrast, hydrogen peroxide earned a score of 4/19 as this method compromised the integrity of the pig ear cartilage.

This research provides a foundation for future testing of best practice methods for removing surrounding tissue from human thyroid cartilage.

Reference(s):

1. Mariam Arif. Ligature Mark on the Neck; How Elucidative? *The Professional Medical Journal.* 22, no. 6 (2015): 798-803.
2. Dawnie Wolfe Steadman, Lisa L. DiAntonio, Jeremy J. Wilson, Kevin E. Sheridan, and Steven P. Tammariello, The Effects of Chemical and Heat Maceration Techniques on the Recovery of Nuclear and Mitochondrial DNA from Bone. *Journal of Forensic Science.* 51, no.1 (2006): 11-17.

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