



A53 **Patterns of Ossification in Macerated Thyroid Cartilages: Implications for Age and Sex Determination**

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After attending this presentation, attendees will be aware that the degree of ossification of the thyroid cartilage should not be used as an indicator in age-at-death assessment.

This presentation will impact the forensic science community by eliminating a commonly used indicator of age at death and by introducing a sex-specific pattern of ossification in the thyroid cartilage.

The ossification process of the thyroid cartilage has been researched extensively using radiographs and Computed Tomography (CT) scans.¹⁻⁶ This research has attempted to correlate age at death with the pattern of ossification, but the results are conflicting. Some suggest there is a standard progression that can be sorted into phases useful in age estimation, while others have found little correlation between ossification and age at death. Despite these conflicting results, ossification of the thyroid cartilage continues to be used as an indicator of advanced age. By examining the bone in these cases, it has been demonstrated that there is no correlation with age and no uniform pattern of ossification. Rather, it was found that there does appear to be a recognizable difference in pattern of ossification between the sexes.

This pilot study examined 32 ossified thyroid cartilages removed at autopsy. The sample included 20 males and 12 females that ranged in age from 25 years to 79 years. The samples were collected from modern forensic cases between 2005 and 2015 at the Maricopa County Office of the Medical Examiner and macerated according to standard protocols. Male and female samples were separated and the thyroid cartilages were scored using standard scoring techniques. The published phases were discordant with observed patterns of ossification in this sample, so photographs of the anterior view of the thyroid cartilages were taken and ordered by degree of ossification. Known age at death was then re-associated with the samples.

No statistically significant correlation between degree of ossification and age-at-death was found in either males or females (Spearman's rank-order: male: $\rho=0.057$, $p=0.813$, $\alpha=0.05$ female: $\rho=0.224$, $p=0.484$, $\alpha=0.05$). The highest degree of ossification was observed in a 31-year-old male and one of the least ossified thyroid cartilages was observed in a 79-year-old male. None of the thyroid cartilages from the female samples was as well ossified as those from the male samples. A statistically significant difference in the pattern of ossification was observed between males and females ($\chi^2=8.5$, $p=0.00349$, $\alpha=0.05$), specifically in the ossification of the superior horns (cornua). Six of 20 males (30%) and 10 of 12 females (80%) exhibit ossification of the superior horns. This element appears to be the last portion of the cartilage to ossify in males, but appears early in the ossification process in females.

The majority of research on thyroid cartilage ossification has been conducted using non-invasive techniques, particularly radiography. Review of this literature demonstrates the difficulty in using these techniques to investigate the cartilage. For example, errors were published in two studies: the first indicates structures in a radiograph that are mislabeled as the thyroid cartilage, the second submits an artistic rendition of the ossified cartilage that is presented upside down.⁷⁻⁸ Further, in this study, comparison of the digital postmortem radiographs obtained at autopsy to the macerated samples demonstrates that ossification is difficult to appreciate in a radiograph.

The results of this pilot study do not support any correlation between age at death and degree of ossification of the thyroid cartilage. The common perception that the presence of an ossified thyroid cartilage denotes very advanced age is patently false. Practitioners should not rely on ossified thyroid cartilage in any way during an age-at-death assessment. Further, this research demonstrates a significant difference between the pattern of ossification observed in males from that seen in females, suggesting that there may be implications for the use of thyroid cartilage ossification in sex estimation. This difference between the sexes is supported by recent immunohistochemical research that demonstrates sex-specific differences in cartilage mineralization of the laryngeal structures.⁹⁻¹⁰ While the results of this pilot study appear to have important implications for skeletal analysis, an increase in sample size should strengthen the findings presented here.



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