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Age and Ossification of the Hyoid Bone: Forensic Implications

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ABSTRACT: Hyoid bones from a medical examiner population were visually and radiographically examined to determine the presence or absence of bony fusion of the greater cornua to the central body. Fusion was found to increase in frequency with age. Hyoid bones fused more frequently in males than in females. Females showed an especially high frequency of unilateral nonfusion.

KEYWORDS: physical anthropology, musculoskeletal system, asphyxia

The human hyoid bone is situated in the upper neck between the jaw and the larynx. It has no direct bony articulation with other parts of the skeleton, but rather is suspended by numerous muscles and ligaments that attach it to the mandible, tongue, styloid processes, thyroid cartilage, cricoid cartilage, clavicles, and sternum. The major function of these muscles is to aid in swallowing and speaking [1].

The hyoid bone develops from the cartilages of the second and third pharyngeal arches. The mature hyoid bone presents a central body to which are attached a pair of lateral, greater cornua (horns) and a pair of superior, lesser cornua (Fig. 1). Ossification begins in three pairs of centers, some before, and some after, birth [2]. The first two ossification centers to fuse are in the central body. The other two pairs of ossification centers are in the greater and lesser cornua and fuse much later, if at all. The cornua are joined to the central body by cartilagenous "joints" (synchondroses) or, later in life, by bony fusion. The frequency and age of onset of bony fusion is poorly described in many anatomy texts and in the forensic science literature.

The bony fusion of the components of the hyoid bone is of interest to forensic pathologists because of the vulnerability of the hyoid bone to fracture during neck trauma and the significance of such fractures in the diagnosis of manual strangulation. The susceptibility of the hyoid bone to fracture has been directly related to age [3-6].

This study correlates the presence or absence of bony fusion of the greater cornu of the hyoid bone with age and sex in a medical examiner autopsy population.

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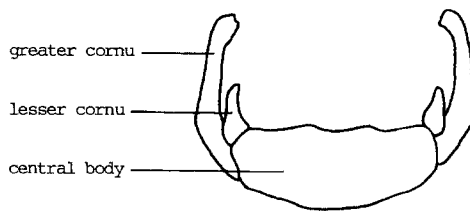


FIG. 1—Human hyoid bone. Ossification begins within bilateral centers in the central body and within each of the four cornua.

Materials and Methods

From 1982 to 1986, hyoid bones from autopsies conducted at the Oregon State Medical Examiner's Office in Portland and at the Ventura County (California) Medical Examiner's Office were intermittently collected. The connective tissues surrounding the hyoid bones in approximately one third of the sample were removed by exposure to a colony of feeding dermestid beetles. The bones were removed from the colony when most of the connective tissue had been removed from them but, in most cases, before the destruction of the cartilagenous joints that sometimes held greater and lesser cornua to the body of the hyoid bone. These were then visually and manually inspected for the presence or absence of bony fusion of the cornua to the body.

The other two thirds of the sample were radiographically examined after removal at autopsy. The presence or absence of bony fusion of the greater cornua to the body was visually determined. Evaluation of the joints of the lesser cornua was not made in the X-rayed sample because of difficulties in visualization.

Data concerning the fusion of the cartilagenous joints of the greater cornua were correlated with age, sex, and racial data from the subject population. For analysis, the cases were divided into age groups by decade. Age Group 1 contained subjects age 0 to 9 years; Group 2, age 10 to 19; Group 3, age 20 to 29; Group 4, age 30 to 39; Group 5, age 40 to 49; Group 6, age 50 to 59; Group 7, age 60 to 69; and Group 8, age 70 or more years.

Results

The hyoid bones from a total of 300 autopsy cases were examined. Of these, 225 were males and 75 were females. The cases ranged in age from 2 months to 92 years. The number of cases in each age group, separated by sex, are presented in Tables 1 and 2.

A total of 600 separate greater cornual joints were evaluated. Forty-five percent of the male joints and forty-one percent of the female joints showed some degree of osseous fusion. Osseous fusion generally was not found until the third decade, and then only in a minority of subjects. The incidence of fusion generally increased with age and reached a plateau in the sixth to seventh decade, with approximately 70% of the joints in men and 60% of the joints in women fused by age 60. Bilateral fusion of the greater cornual joints was more frequent in men than in women in all age groups after the third decade. These results are presented in tabular form in Tables 1 and 2 and graphically in Fig. 2.

An unexpected finding was the frequency of unilateral osseous fusion of the greater cornual joints at the time of death (Fig. 3). By the third decade the percentage of cases with unilateral fusion was significant and remained so into old age. In Age Groups 3 through 8 (age 20 and older), 17% of the men and 40% of the women demonstrated unilateral nonfusion. In those cases with unilateral fusion, no significant difference in right- versus left-side fusion was found.

TABLE 1—Fusion of hyoid bone greater cornua in males.

Age Group, years	Unfused	One Side Fused	Both Fused	Total
1 (0-9)	3(100%)	0	0	3
2 (10-19)	22(100%)	0	0	22
3 (20-29)	34(69.4%)	6(12.2%)	9(18.4%)	49
4 (30-39)	20(40.0%)	9(18.0%)	21(42.0%)	50
5 (40-49)	11(27.5%)	12(30.0%)	17(42.5%)	40
6 (50-59)	11(35.5%)	3(9.7%)	17(54.8%)	31
7 (60-69)	2(14.3%)	2(14.3%)	10(71.4%)	14
8 (70+)	4(25.0%)	2(12.5%)	10(62.5%)	16
Total	107(47.6%)	34(15.1%)	84(37.3%)	225

TABLE 2—Fusion of hyoid bone greater cornua in females.

Age Group, years	Unfused	One Side Fused	Both Fused	Total
1 (0-9)	3(100%)	0	0	3
2 (10-19)	3(75.0%)	1(25.0%)	0	4
3 (20-29)	10(58.8%)	4(23.5%)	3(17.6%)	17
4 (30-39)	3(23.1%)	8(61.5%)	2(15.4%)	13
5 (40-49)	5(38.5%)	6(46.1%)	2(15.4%)	13
6 (50-59)	3(33.3%)	2(22.2%)	4(44.4%)	9
7 (60-69)	2(22.4%)	5(55.6%)	2(22.2%)	9
8 (70+)	2(28.7%)	1(14.3%)	4(57.0%)	7
Total	31(41.3%)	27(36.0%)	17(22.7%)	75

Of the cases, 89% (267) were Caucasian, 6% (18) black, 4% (12) Oriental, and 1% (3) unknown. No statistically significant interracial differences in greater cornual fusion rates for either males or females were found.

Discussion

The presence of bony union of the greater cornua to the body of the hyoid bone is of limited use in the forensic science estimation of age in a badly decomposed or partially skeletonized human body. Though the data indicate a trend toward greater frequency of bony union with increasing age, significant numbers of middle aged and elderly people, especially women, have nonunion. Unpublished data from a large series of cases in which degrees of bony union were evaluated indicate a more consistent trend toward ossification with age [7].

Of interest to the forensic pathologist is the frequency of nonossification of the hyoid greater cornual joint in middle and old age. It is true that the probability that an individual's hyoid bone would be completely ossified increases with age, and thus would be more susceptible to fracture during manual strangulation because of loss of elasticity. However, strangulation should not be ruled unlikely on the basis of a hyoid free of fracture, even in advanced age, since a significant percentage of elderly people have persistent, flexible, greater cornual joints.

Of greater importance to the forensic pathologist is the frequency of unilateral nonfusion, especially in women. Instances have been reported where innocent persons were charged and

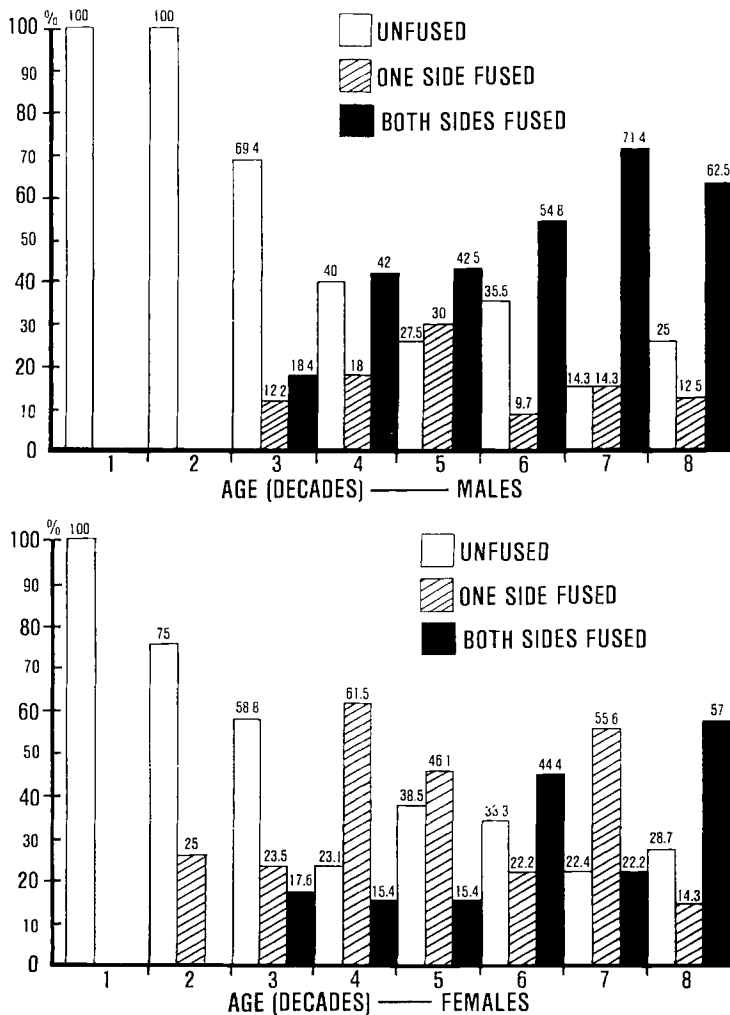


FIG. 2.—Frequency of osseous fusion of hyoid bone greater cornua, expressed as a percentage, is compared with age (in decades). Percentages with nonfusion, unilateral fusion, and bilateral fusion are compared between (a) males and (b) females.

found guilty of homicide by strangulation in which a major piece of evidence was the mistaken conclusion by the pathologist that the hyoid bone had been “fractured” [3]. Since females are commonly victims of manual strangulation, and since the data in this study indicate that more than one third of adult women have unilateral nonfusion of the greater cornua, it is important for the pathologist to examine the hyoid bone carefully. It should be removed and visually examined for evidence of hemorrhage in any area of mobility. The diagnosis of a premortem fracture should not be made in the absence of hemorrhage at the fracture site.

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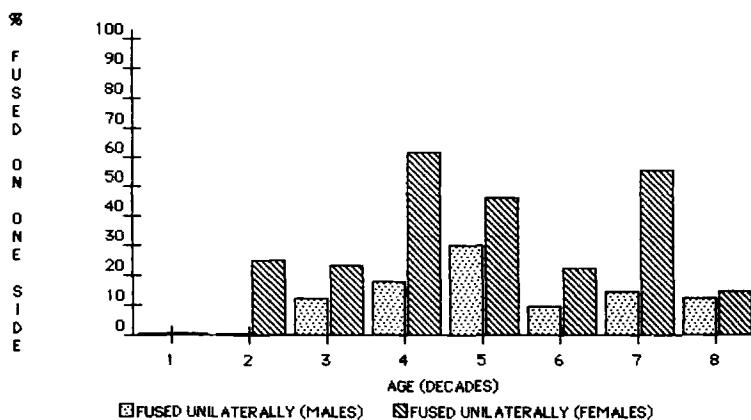


FIG. 3—Frequency of unilateral osseous fusion of hyoid bone greater cornua is compared between males and females by decade.

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