

DIET AND AGE-AT-DEATH DETERMINATIONS FROM MOLAR ATTRITION A REVIEW RELATED TO THE LOW COUNTRIES

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ABSTRACT

To elucidate the impact of diet on age-at-death determinations based on molar attrition a comparison was made between the established rate of attrition in three populations; a pre-mediaeval (British), a late mediaeval (Dutch) and a 17-18th century (Dutch) (western European). It appeared that the rate decreased dramatically during the overall time span and that this change was probably diet related and owing to the coarseness of foodstuffs. This result strongly indicated that molar age-attrition tables should only be used for age-at-death determinations if their application is restricted to a particular cultural period and diet. (*J Forensic Odontostomatol* 2001;19:18-21)

Keywords: attrition, age determination, molar, diet

INTRODUCTION

For many years Brothwell's⁶ method for age-at-death determination has been the most popular and widely used of the many existing ones based on molar attrition.¹⁻⁹ With the help of his pictorial classification, the degree of molar attrition, that is the pattern of occlusal wear of enamel and exposed dentine, could easily be scored with the naked eye (Fig. 1). For subsequent age-at-death diagnosis the interrelated scores of the juxtaposed first, second and third molars could be directly linked to a certain age-at-death interval in the accompanying age/attrition table (Fig. 2). It should be realized however that the method was developed by observations on western European skeletal remains from the pre-mediaeval period and that owing to cultural evolution and ongoing changes in food processing the coarseness of the diet and thus the rate of resulting molar attrition decreased in time. Age/attrition tables have consequently to be adapted to such shifts. Although the influence of cultural variability on tooth wear was stressed as early as 1971,⁵ in practice very few forensic and archaeological investigators using the method applied it with a correction for this factor.³ To elucidate the impact of diet on age-at-death determinations based on molar attrition a comparison was made between the known data from three populations, a pre-mediaeval (British), a late mediaeval (Dutch) and a 17-18th century (Dutch) (western European).

MATERIALS AND METHODS

The British material investigated by Brothwell⁶ consisted of specimens dating from the neolithic (4000 BC) to mediaeval period. Skeletal ages-at-death of the individuals were established by observing the ageing status of the symphyseal face of the pubic bone. The late mediaeval Dutch material consisted of the dentitions of 76 citizens buried between 1275-1575 AD in the churchyard of a Franciscan friary in the City of Dordrecht.¹⁰ The 17-18th century material was composed of the complete dentitions of 45 Dutch whalers buried on Spitsbergen.¹¹ In the latter two samples gender and skeletal ages-at-death were determined according to the Workshop of European Anthropologists¹² which, together with other age indicators, also uses the symphyseal face of the pubic bone as an indicator.

In all dentitions molar attrition was scored according to Brothwell⁶ and Maat and Van der Velde.¹¹ The numerical classification of molar wear had an ordinal interval scale from one (no wear) to seven (only roots remaining) (Fig. 1). For reasons of computing this classification was transcribed to algebraic numbers, for example: 1+ = 1.333 and the attrition on the most intact side of the mouth was recorded. On that side all maxillary and mandibular molars were scored to achieve a mean for M1 (first molar), M2 (second molar) and M3 (third molar). Data were

only eliminated from calculations in case of atypical wear patterns, for example M1 scoring lower than M2, while the functional age of M1 should be six years in advance due to its earlier eruption. With respect to the data collected by Maat *et al.*¹⁰ and Maat and Van der Velde¹¹ means were compared with student's t test for paired observations and regression analyses were done using the simple linear regression model.

RESULTS

After computing the recorded scores the results from the linear regression model were displayed similarly to Brothwell⁶ in his age-attribution table (Figs. 2, 3 and 4).

In the pre-mediaeval period the degree of attrition increased gradually from 3-(M1), 2+(M2), 1+(M3) for the 17-25 years interval to 5+(M1), 5(M2), 4+(M3) for the 35-45 years interval and to any degree greater than that for the 45+ years age group⁶ (Fig. 2).

In the late mediaeval period the degree of attrition increased from 3-(M1), 2-/2(M2), 1+(M3) for the 14-17 years interval to 5-/5(M1), 4(M2), 3+(M3) for the 65+ years age group¹⁰ (Fig. 3).

In the 17-18th century samples the degree of attrition increased from 2+(M1), 1+/-2-(M2), 1(M3) for the 14-17 years interval to 5-(M1), 4-/4(M2), 3/3+(M3) for the 65+ years age group¹¹ (Fig. 4).

With respect to the data from the late mediaeval period and from the 17-18th century, it should be mentioned that for every degree of attrition of M1, M2 and M3 the 95% confidence limits for single observations showed an accompanying age-at-death interval of ca. 25 years.^{10,11}

DISCUSSION

After comparing the three age/attrition tables (Figs. 2, 3 and 4) it was clear that at least in some parts of western Europe i.e. Britain and the Low Countries, the rate of molar attrition decreased dramatically during the time span covered by the three samples. The average wear pattern as seen in the 35-45 age interval during the pre-medieval period was never reached during later periods, even by individuals of the oldest age-at-death interval (65-70+ years). The average wear pattern as seen in the 25-35 age interval during the pre-mediaeval period was only reached

in the 55-65 age interval of the late mediaeval period and in the 65+ age interval of the 17-18th century. If compared to the pre-mediaeval period the latter two shifts in functional age of teeth represented approximately 30 and 40 years respectively.

These decreases in rate of attrition were most likely the result of a substantial decrease in coarseness of foodstuffs in the diet. For instance it was known that during the transition from the mediaeval period to the 17-18th century grain millers started to sift flour through fine cloth sieves to remove coarse particles of bran.^{13,14} As a matter of course the overall rate of attrition decreased considerably. Presently, due to further substantial reductions in the amount of abrasives in our diet, molar attrition of "modern man" seems to have been reduced to a trifle. The impact of these diet changes has to be taken into consideration when applying molar age/attrition tables for age-at-death determinations.

The best way to do this is by computing a specific reference age/attrition table for a particular cultural period with the help of dentitions of individuals of documented or osteologically well established skeletal age from that same period. The paragraph on Materials and Methods and Figs. 3 and 4 show how this can be accomplished. More simply, and in an even more direct way this can be done by hand by lining up in order of increasing age the dentitions of individuals of well established skeletal age and once the ranking is complete the ages-at-death of the unknowns can be read by comparison and seriation (fitting in) of their molar attrition. Whatever procedure is used it has to be kept in mind that, if a statistical confidence level of 95% is required, the resulting individual skeletal ages will always fall within an age range of ca. 25 years which is the closest realistic result attainable.

It is not recommended that a molar age/attrition table be constructed by extrapolating the rate/gradient of molar wear from data of skulls of the young, of which the age was assessed from the state of development of dentition, for the estimation of ages of older individuals.^{2-4,8,9,15} The basis for this method is a calculated attrition rate from the difference in attrition between M1 (erupting at the age of 6 years) and M2 (erupting at the age of 12 years). In such a procedure those six years of functional age and its

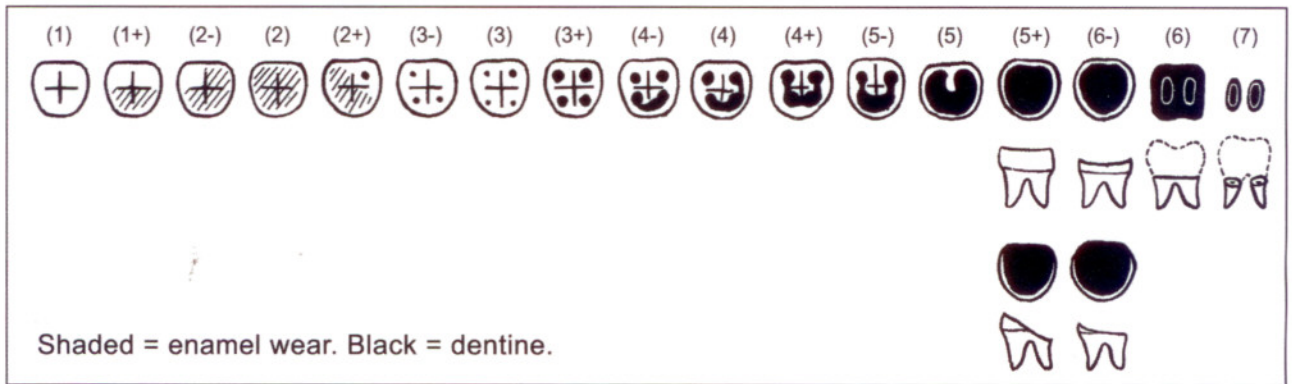


Fig.1: Numerical classification of molar attrition modified from Brothwell⁶

AGE INTERVAL (years)**	17 - 25			25 - 35			35 - 45			45+		
MOLAR	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
NUMERICAL CLASSIFICATION	3	2 ⁺	1	4 ⁺	4 ⁻	3 ⁻	5 ⁺	5	4 ⁺	Any greater degree		
WEAR PATTERN										Any greater degree		

* Modified from Brothwell, and scored according to Maat and Van der Velde.^{6,11} Several early British groups.
 ** Ages are skeletal ages assessed by the pubic symphyseal face.

Fig.2: Molar attrition during the pre-mediaeval period*

AGE INTERVAL (years)**	14 - 17			17 - 25			25 - 35			35 - 45			45 - 55			55 - 65			65 - 70+		
MOLAR	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
NUMERICAL CLASSIFICATION	3 ⁻	2/2	1 ⁺	3/3	2	1 ^{+/2}	3/3 ⁺	2 ^{+/3}	2/2	4 ⁻	3/3	2/2 ⁺	4	3/3 ⁺	2 ^{+/3}	4 ^{+/5}	4 ⁻	3	5 ^{/5}	4	3 ⁺
WEAR PATTERN																					

* Scored according to Brothwell, and Maat and Van der Velde.^{6,11} N = 76 citizens buried in a churchyard of a Franciscan friary in the City of Dordrecht i.e., 3, 11, 19, 15, 14, 10 and 4 cases for the successive age intervals.
 ** Ages are skeletal ages assessed according to the WEA.¹²

Fig.3: Molar attrition during the period ca. 1275-1572 AD*

AGE INTERVAL (years)**	14 - 17			17 - 25			25 - 35			35 - 45			45 - 55			55 - 65			65 - 70+		
MOLAR	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
NUMERICAL CLASSIFICATION	2 ⁺	1 ^{+/2}	1	2 ^{+/3}	2	1 ^{+/1}	3/3	2/2 ⁺	2/2	3 ^{+/4}	2 ^{+/3}	2/2 ⁺	3 ^{+/4}	2 ^{+/3}	2 ⁺	4 ⁻	3/3	2 ^{+/3}	5 ⁻	4/4	3/3 ⁺
WEAR PATTERN																					

* Scored according to Brothwell, and Maat and Van der Velde.^{6,11} N = 45 whalers with complete dentitions buried on Spitsbergen (Maat and Van der Velde)¹¹ i.e., 2, 7, 9, 9, 3, 12 and 3 cases for the successive age intervals.
 ** Ages are skeletal ages assessed according to the WEA.¹²

Fig.4: Molar attrition during the period ca. 1650-1800 AD*

rate/gradient have to be extrapolated ten times, assuming the rate will remain constant throughout life, to estimate the ages of the elderly! It is possible however that such a procedure overstretches the short trend of the onset period because after the age of 12 years the overall occlusal surface will change in size and aspect, the masticatory power will increase, and in many cultures after infancy the diet will change.¹⁶ In short, too many unpredictables would be taken for granted in order to achieve realistic forecasts.

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