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Age estimation by dental attrition in an independently controlled early 19th century sample from Zwolle, The Netherlands.

This paper reports the investigation of macroscopic aging methods in a skeletal sample from the early 19th century, excavated in The Netherlands and containing a number of individuals of known age and sex. A method is proposed for calibrating age estimations based on dental attrition.

Key words: Dental attrition, Age estimation, Age calibration

Introduction

During the 1980s the Broerenkerk, in the Dutch city of Zwolle, underwent substantial restoration. The installation of a sub-floor heating system constituted its last stage. This operation would, on the one hand, lead to future inaccessibility of the archaeological and physical anthropological information contained within the church building and, on the other hand, destroy such information, including the human skeletons buried within the church. Therefore in the winter of 1987-88 an excavation was conducted with a twofold purpose: 1. to collect as many data as possible on the history of the church building and 2. to salvage at least part of the human skeletal material present under the church floor. This last objective was particularly attractive because of the availability of the burial register from the period 1819-28, i.e. the last ten years in which burial took place within the church. This provided the possibility of identifying 141 individuals as to their sex and 138 individuals as to their age at death out of a total of 529 individuals. In a number of cases information was also available pertaining to the profession of the deceased. Thus this identified sample enabled the investigators to test their anthropological methodology. In this paper the testing of the age estimations by the analysis of dental attrition will be presented.

The 141 identified individuals all date from the period 4 December 1819 to 31 December 1828. The historical record (Hagedoorn 1992) showed that the skeletal sample represents only part of the town's population at the time, i.e. the social middle class (*vide* also Bouts et al. 1992; Constandse-Westermann & Bouts in press; Constandse-Westermann et al. in prep.). Furthermore, the number of children in the sample is biased. Aten (1990, 1992a) states that the excavation trenches were chosen in such a manner that a maximum number of identifiable individuals and a maximum number of young children could be expected. Therefore, the sample is at best representative for the social middle class of the 19th century population of Zwolle, and probably contains an over-representation of the younger children's age classes.

The investigation

A group of students from the University of Amsterdam was involved in the excavation and carried out the methodological investigations pertaining to the morphological and metrical sex diagnoses and macroscopic age estimations (auricular surface, cranial sutures and pubic symphysis) of the identified sample. The results of this research were then applied to the total skeletal sample (Aten 1990, 1992b; d'Hollosy 1989; Stikker 1989).

In this paper the age estimations have been based on dental eruption and attrition. The estimations of the degree of attrition have been made according to Pot, who designed a detailed aging scale following Miles (1963) and Brothwell (2nd ed. 1972) (Perizonius & Pot 1981) and since considerably refined this method (Pot 1986, 1988a, b; Pot & de Groot 1989; Pot et al. 1989). The attrition scale initially used for the estimations in this paper is presented in Figure 1. In the first instance age estimations of the identified individuals have been made. Thereafter these results have been compared to the historically known ages at death and appeared to need calibration. This calibration of the results and the comparison of the possibilities of our dental method with those of other macroscopic aging techniques form the subject matter of this contribution. The use of the calibrated age classes on the total skeletal population, the results of the demographic analysis of the Zwolle sample and the data on the dental pathology are or will be published elsewhere (Bouts et al. 1992; Constandse-Westermann & Bouts in press; Constandse-Westermann et al. in prep.).

Methods

Registration

Our observations have been registered by means of a specifically designed computer programme which is being developed by Bouts and Verhoeven (Bouts & Pot 1989; Bouts et al. 1992). This programme enables the investigator, via a three button mouse, to register his/her observations. The user sees on the screen a graphic representation of the dentition. By choosing the appropriate codes from the menus at the top of the screen he/she can, for each element, *c.q.* each corresponding site in the jaw, score its presence, *post mortem* or *ante mortem* loss, state of eruption, pathology, degree of attrition, etc. In Figure 2 an example of a recorded dentition is presented. The codes and symbols used are explained in the caption to that figure. The data contained within the graphic codes/symbols can be exported into a comma delimited ASCII file which then can be imported into most spreadsheet and/or statistical programmes for further analysis.

The age estimations

1. The method as proposed by Pot

The age estimations of the children and adolescents have been largely based on the state of development of the deciduous and permanent elements (according to Ubelaker 1989), with the degree of their attrition playing only a subordinate role.

The age estimations of the adult individuals were mainly based on their degree of attrition. However, before making the actual estimations, we took into consideration how the dentition had been functioning during the subject's lifetime. In some cases it was evident from the total attrition pattern that mastication had taken place mainly on one side of the jaw (e.g. because of a probably painful infection in one of the opposite quadrants). In other instances the attrition of a specific element had been halted or retarded because of early *ante* *mortem* loss of its antagonist. In those cases it was often observed that the unhampered growth of the element in question had caused it to surpass the occlusal plane, thereby disturbing the expected regular masticatory pattern in the dentition. When any of the above was observed, and also when a dentition showed severe unexplained discrepancies in its attrition pattern, we evaluated carefully which elements were most likely to have a degree of attrition which was representative of their functional period and therefore could be used for an age estimation. Needless to say these phenomena could not always be observed, particularly when the inspection of the antagonist elements was not possible due to the absence of one of the jaws.

According to Pot (1988a, b) the second molars were considered to be the most diagnostic elements. Their average degree of attrition is the optimal basis for an age estimation because: 1. the large size of the occlusal planes of all molars leads to clear attrition patterns, 2. contrary to the third molars, the first and second molars, having no deciduous predecessors, show relatively little chronological variability in their development and therefore in the start of their functional period, and 3. the second molars are less affected than the first by pathological lesions (Constandse-Westermann & Bouts in press; Constandse-Westermann et al. in prep.; Pot 1988b, unpublished material; Pot et al. 1989).

The complete dentitions provided the possibility to relate the attrition of the other elements to that of the second molars. This relation was used in order to determine the age classes of those individuals whose second molars were missing. In those cases priority, in terms of reliability, was given to an evaluation by means of the first and then the third molars. When all molars were missing the average degree of attrition of the premolars and the anterior teeth (canines and incisors), i.e. the PCI-index, was used.

Finally, when there was a dearth of usable and reliable dental elements to execute an age estimation, a rough indication of the individual's age at death was derived from the degree of alveolar resorption. This was done by visual inspection of: a. the length of the exposed parts of the roots, b. the depths of the remaining (empty) alveoles and c. in the mandible, also the distance between the alveolar rim and the upper rim of the *foramen mentale*. It was mainly for the older individuals that we had to use this method, expected by us to be the least reliable. Also in these cases the condition of the total dentition was taken into account, i.e. we refrained from making age estimations on the basis of elements of which an excessive length of the exposed root parts had been caused by an *ante mortem* lost antagonist, or bone sites where local parodontal or gingival infections had led to a more pronounced alveolar resorption than in other parts of the dentition.

2. The attrition rate

In addition to the status of the individual dentitions studied, another factor had to be taken into account in our age estimations. This was the rapidity of the attrition process, i.e. the attrition rate. This rate has been found to vary between populations with their diet, food preparation techniques and habitual activities involving the dental apparatus (e.g. Walker et al. 1991 and sources therein). It has also been stated that the attrition rate varies with age. However, statements on the nature of this variation are ambiguous. On the one hand the process is considered to be retarded with increasing age because 1. the attrition of only the tips of the cusps in the lower age classes would be a more rapid process than that of the total occlusal plane in older individuals (Brothwell 1989), and 2. the vigour of mastication would decrease with individual age (Miles 1958). On the other hand, the process is stated to increase with age because the attrition of the softer dentine would proceed faster than that of the enamel (Brothwell 1989). Moreover, estimating the attrition rate by analyzing the differences see corrections for this page

in degree of attrition between the first and second molars, it has to be taken into consideration that the attrition rate of the second molars is in most cases somewhat lower than that of the first molars (Miles 1963). Because of this the length of the period, in years, corresponding to a specific difference in degree of attrition between these two elements would decrease with age. This would result in an apparent increase in the attrition rate with age.

In order to resolve this contradiction in the real or apparent age effects to be expected, we scored the differences in attrition between the first and the second molars, per individual and per quadrant, in the complete dentitions from all those dental samples, which have been scored within the framework of our dental research programme in a systematic and comparable manner (Bouts & Pot 1989; Bouts et al. 1992; Pot 1988a, b, unpublished material).[1] The results were subdivided into three, age-related, groups, i.e. I: differences on the basis of second molars with a degree of attrition 2+, II: on the basis of second molars in the attrition classes 3- to 3+, and III: those in the attrition classes 4. The results are presented in Table 1. The table demonstrates that only in three out of 13 cases did a significant difference occur between the groups I and II. Only in group III is there a consistent decrease of the magnitude of the differences observed, relative to groups I and II. Considering our figures we suspect that this decrease is mainly due to the fact that the 'space' for large differences is relatively limited in group III, because the maximum degree of attrition is fixed at 7. Moreover, as is also apparent from the low N-values within this group, we observed a lack of first molars with high degrees of attrition, which could result in large differences. For obvious reasons many of those were lost *ante mortem*. Therefore we must conclude that our figures do not indicate a steady decrease of the attrition rate with age. Groups I and II only differ in 23 % of the samples and in a number of samples the group II differences are even (non-significantly) larger than those in group I. The smaller differences in group III may partly be due to a decreasing attrition rate in the higher age classes, but other explanations for the observed phenomena are also possible.

In view of these results we propose that the averages of the differences between the first and the second molars, preferably those in the groups I and II, are a good measure for the attrition rate in a dental sample and/or in the population it represents. This measure proved to be important in the calibration and therefore the interpretation of the age classes resulting from the attrition analysis.

The dental sample

Our dental sample comprised 119 identified individuals from whom remains of their dentitions and/or jaws have been preserved (84.4 % of the total identified sample). The composition of the dental sample is presented in Table 2. Thanks to the careful excavation the 'preservation rate' (Pot 1988b) of the dental material was relatively high (as is more elaborately discussed in Constandse-Westermann & Bouts in press; Constandse-Westermann et al. in prep.). Between 76.0 (anterior teeth) and 80.8 % (premolars) of the elements in the adult permanent dentitions were available for investigation and/or rendered information as to their attritional and/or pathological status. The preservation rate of the bone sites varied between 84.4 (molars) and 86.4 % (premolars).

The high informative quality of the Zwolle dentitions enabled us to make age estimations for 112 individuals. Only for 2 males and 5 females were such estimations impossible, due to the pathological condition of their dentitions. For three more identified females age at death had not been noted in the church register. Therefore our analysis and calibration have been based on 109 paired observations/registrations: 29 on children and adolescents, 37 on males and 43 on females.

The age estimations

The children and adolescents

The investigation of the identified dental sample demonstrated that the age estimations of the children and adolescents, based upon the stages of development of their dentitions, were highly reliable (Fig. 3). Two of the three discrepancies in the 0-1 years (estimated) age class were caused by children who had just reached the age of one year at the time of their death. In addition there are four individuals, inserted incorrectly in the (estimated) age class 15-18, based on the state of development of their third molars. They were in fact 19, 19, 20 and 21 years old. This is a clear indication of the variable chronology of the development of the third molar, which is not yet fully developed and erupted in all individuals of ca 18 years old. In view of this we decided to discard Pot's (1988a, b) highest adolescent age class (15-18), and to use an age class of 15-21 instead.

The adults

The uncalibrated age estimations performed on the identified dental sample, based on the original age classes as proposed by Pot (Perizonius & Pot 1981; Pot 1986, 1988a, b; vide Fig. 1), show a large number of deviant evaluations in the first instance (63 out of the 80 adult individuals for which both an estimated and a real age were available, i.e. 78.85%; Fig. 4). This result is partly due to the fact that the sample represents a group of individuals dating from ca 1800 AD, with very high percentages of dental pathology, disrupting a regular attrition process as well as inhibiting its correct evaluation. We observe:

1. a large variability of the real ages within each estimated age class, resulting in:
2. a strong overlap between the real age distributions in the estimated age classes;
3. an over-representation of too low estimates, especially in the estimated age classes between 25 and 45 years, resulting in a shift of the estimated age classes in relation to the real ages; and
4. many individuals showing an extreme discrepancy between their real and their estimated age class.

A (combination of) the following solutions can be proposed, i.e.

1. ignoring the results of the age estimations predicted to be the least reliable (i.e. exclusively on the basis of the PCI-index and/or alveolar resorption);
2. the use of larger age classes;
3. accepting a small measure of overlap between the estimated classes;
4. calibration of the age classes as originally interpreted by Pot; and
5. using the classes not in terms of calendar ages but only as ordinal classes. However, the advantages of this last solution have not been investigated by us, as satisfactory results were already obtained using some other solutions.

The first solution was rejected on three grounds. Firstly it meant that we would not be able to estimate the age of 39 of our 80 adult identified individuals. i.e. 48.75 %. More importantly, it would cause systematic bias, excluding specifically the older individuals, having the higher frequencies of dental pathology, from the age estimations (Table 3, note 1, and *vide* Constandse-Westermann *et al.* in prep.). This would preclude the possibility to study the age distribution in the total group of individuals as well as the frequencies of the pathological phenomena in the various age classes. In the third place it appeared from our analysis that these estimations, *contra* our expectations, do not lead to significantly more deviant results than those based on the attrition of the molars (*vide* Table 3, note 1).

A better option was a combination of the solutions 2, 3, and 4. A justification for the see corrections for missing footnote

most important aspect of the procedure, the calibration of Pot's interpretative age classes, can be found in Table 1. The table demonstrates that considerable differences in the attrition rate are extant between the samples studied and therefore that the age/attrition scales currently employed cannot be pertinent to all (pre)historic samples. In spite of the fact that the dates of some of the samples can only be determined within rather wide limits, we observe a clear chronological trend. The three samples from the 17th-18th century show the lowest attrition rates, with the Broerenkerk material being anomalous, even within this small series of three samples. The low attrition rate in the dentitions from Zwolle implies a slow attrition process and therefore a higher age at which a specific attrition stage is reached, justifying a calibration.

Using a combination of the solutions 2, 3 and 4 leads to the result presented in Figure 5. The percentage of incorrectly classified individuals is reduced from 78.75 % to a much more acceptable 20.00 %. Only three extreme discrepancies (> 12 years) between the real and the estimated ages were observed. Already before the comparison with the real ages took place, all three were considered to be dubious estimates.[2] Without these three the average discrepancy was 3.8 years for the males (maximum 8 years) and 6.3 years for the females (maximum 11 years). The higher average discrepancy in the female sample is due to their greater prevalence of dental pathology (Bouts et al. 1992; Constandse-Westermann et al. in prep.). Finally, Table 3 shows that the estimates based exclusively on the PCI-index and/or alveolar resorption give results which are, in fact, of equal reliability to those based on molar attrition: after the calibration only eight of these 39 estimates (20.5 %) were deviant. As a result to the above, the calibrated age classes have been used for the age estimations of the unidentified individuals in the sample from Zwolle (Constandse-Westermann & Bouts in press; Constandse-Westermann et al. in prep.).

A comparison of the four aging methods applied to the identified sample from the Zwolle skeletons

In Table 4 four macroscopic methods for age estimation which have been tested by the analysis of the identified Zwolle sample are compared. These are 1. the chronological metamorphosis of the *facies auricularis* (Lovejoy et al. 1985), 2. pubic symphyseal aging (Meindl et al. 1985; Katz & Suchey 1986) and 3. cranial suture closure (Meindl & Lovejoy 1985). In our evaluation a number of factors have been considered, i.e. 1. the applicability of the methods, measured by the percentages of individuals for which each method could be employed, 2. the numbers of resulting age classes, their range and their mutual overlap, as a measure of the precision of the results, and both 3. the percentages of deviant estimates and 4. the average discrepancies, as measures of the reliability of same. In the analyses of the estimates by all three above age indicators, the age classes proposed in the original publications have been calibrated, using the historically known ages at death. This procedure was followed in order to obtain insight into their optimal resolution.

The table demonstrates that the age estimations based upon dental attrition provide somewhat better results than those obtained from the other methods, even in this sample with its high frequencies of dental pathology. The study of progressive suture closure (lateral anterior and vault systems) in the Zwolle crania (Stikker 1989) permitted estimates for 74-65 of the 112 individuals (66.1-58.0 %). Only by using two calibrated age classes could we obtain estimates within the correct class for 85.1-81.5 % of the 112 adult individuals in the identified sample. Study of the *facies auricularis* resulted in 80.3 % correct classifications within only three calibrated age classes, with an overlap of 16 years (d'Hollosy 1989). Somewhat better results were obtained from the study of the *symphysis pubica*, i.e. 85.7 % of the individuals were classified within their correct calibrated age class, also using three age classes with a 15 years overlap. However, this method could only be applied to 28 of the 112 individuals (25.0 %) (d'Hollosy 1989). For all three above methods the use of four calibrated age classes with no or, at most, a 5 years overlap, led to a, sometimes considerable, decrease of the percentage of correct classifications (suture closure: 56.8-63.1 % correct, *facies auricularis*: 24.6 % correct and *symphysis pubica*: 67.9 % correct).

Our analysis and calibration of the estimates by dental attrition and alveolar resorption yielded 80.0 % correct classifications into four age classes with an overlap of only 5 years. The method could be applied to 92.2 % of the adult dentitions, i.e. 74.1 % of all adult individuals in the identified sample. The table demonstrates that our average discrepancies are of the same order of magnitude (for the females) or even smaller (for the males) than those from other methods (*vide* also the foregoing section). Furthermore, the age classes into which the individuals could be subdivided by the dental attrition aging method are more evenly spread over the adult life period than in any of the other methods.

Finally it should be noted that estimating age by dental attrition is the only one of the four methods discussed, which provides us with the possibility to calibrate the results without necessarily having a sample of known age from the same population/sample. This can be accomplished by determining the position of its average attrition rate within the framework of the series presented in our Table 1. In this way the rapidity of the attrition processes within the population or sample in question can be taken into consideration. Our calibration method also enables the investigator to analyze differences in the attrition rate between various groups within the sample, e.g. males and females, or status groups, when differences are expected in food patterns or specialized tasks in which the dentition may be used.

Conclusions

Our analysis has demonstrated that, by analysing the *degree* of dental attrition in individuals, taking into account the *average rate* of attrition in the total sample/population, a high percentage of correct age classifications into four age classes with only a slight overlap can be obtained. Because in most skeletal samples the teeth are among the best preserved parts, the method can usually be applied to a relatively high percentage of individuals. We recommend strongly that the quantitative basis of our Table 1 be reinforced by analysis of the difference in attrition between the first and the second molars in other skeletal series of known age and in series where a reliable comparison can be made between dental and other (e.g. histological) age estimators. Particularly the analysis of dental attrition data on (sub-)recent ethnographic populations, with relatively high attrition rates and recorded vital statistics, could be useful in this respect.

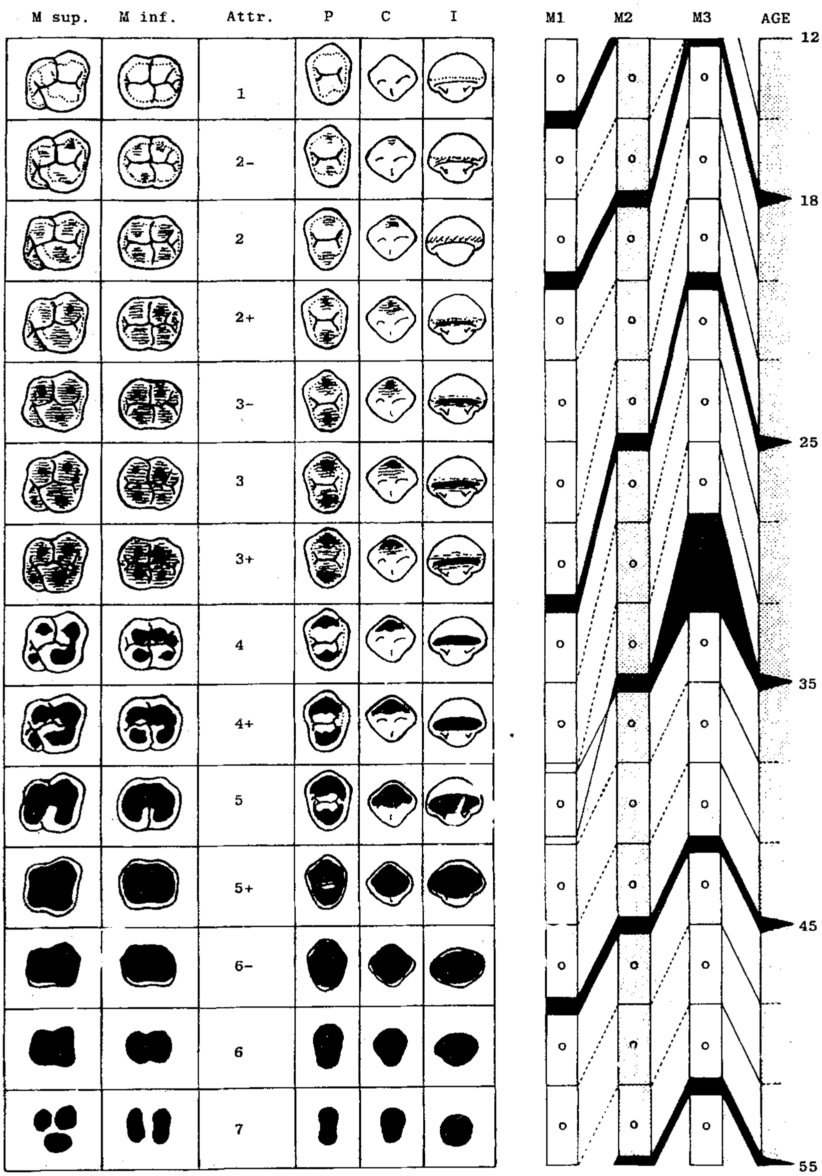

Figure 1 - The attrition scale as originally designed and refined by Pot (1988b). The observed attrition is followed horizontally until the relevant column (M1, M2 or M3) is reached. Following the oblique lines yields the age class.

link to a few notes on attrition schema

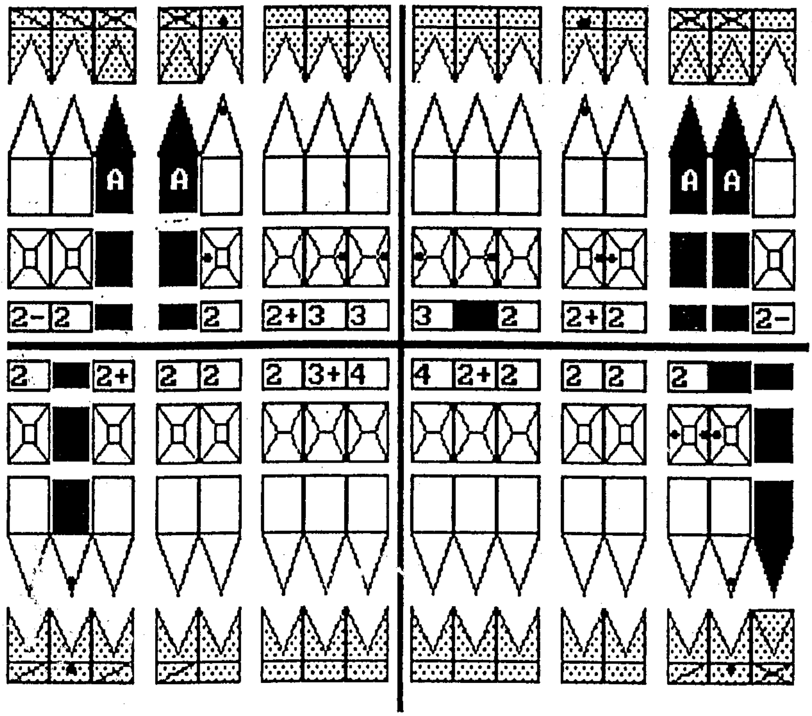

Figure 2 - An example of the recorded dentition of an adult woman of 48 years old. It should be interpreted as follows.

In the maxilla the elements 18 and 17 are present and somewhat worn (2- and 2). The 16, 15, 26 and 27 have been lost *ante mortem*; their alveoles are no longer present. The other elements of the maxilla are present. Of these, the 14, 12, 11, 21, 22, 24 and 25 are carious, the 14 in its distal facet, 12 and 11 in their mesial facets, etc. The elements 24 and 25 have an approximal carious lesion. Two elements (14 and 24) also have exposed pulp cavities (the dots in the 'root') and periapical lesions (the dots in the bone sites). The alveoles of all upper incisors and canines and of the left second premolar could be inspected and are healthy, while the alveoles of the elements 18 and 17 could not be inspected (the oblique lines). The caries of the element 22 was so deep that its attrition could not reliably be registered.

In the mandible we find two more symbols. The element 38 is absent, and no alveole is visible. In this case, however, it is not clear whether the element has been lost *ante mortem* or whether it is congenitally absent (no 'A' in the symbol for the tooth). In the element 47 the carious lesion has progressed so far that only root rests are present in the jaw.

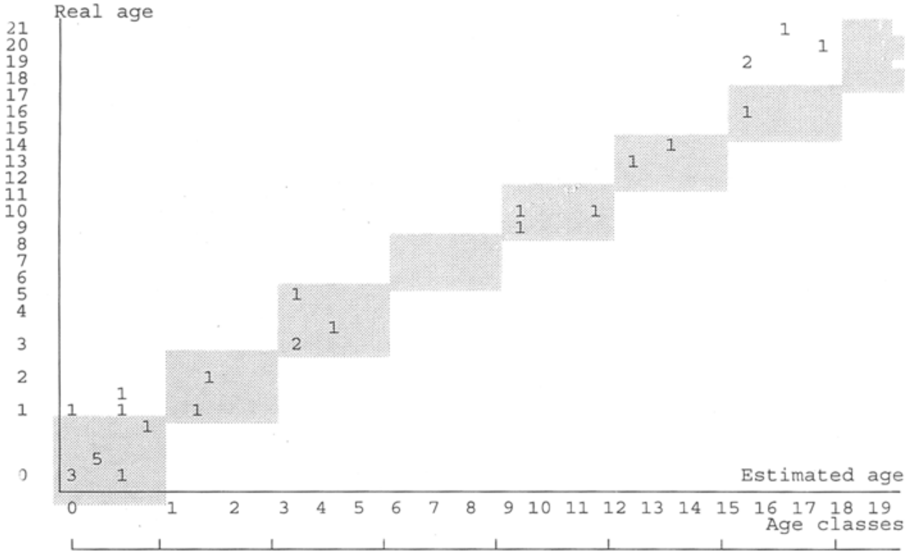

Figure 3 - The real and the estimated ages of the children and adolescents in the identified sample from the Broerenkerk. The shaded areas indicate correspondence.

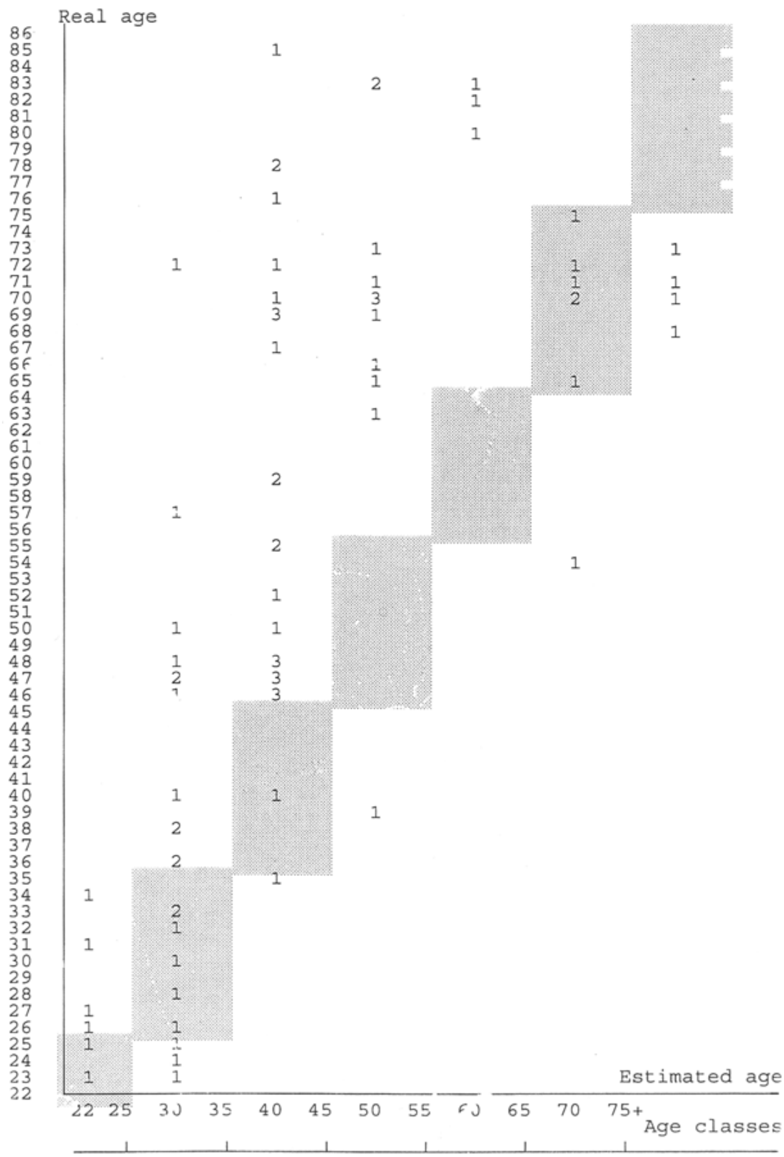

Figure 4 - The real and the uncalibrated estimated ages of the adult individuals in the identified sample from the Broerenkerk. The shaded areas indicate correspondence.

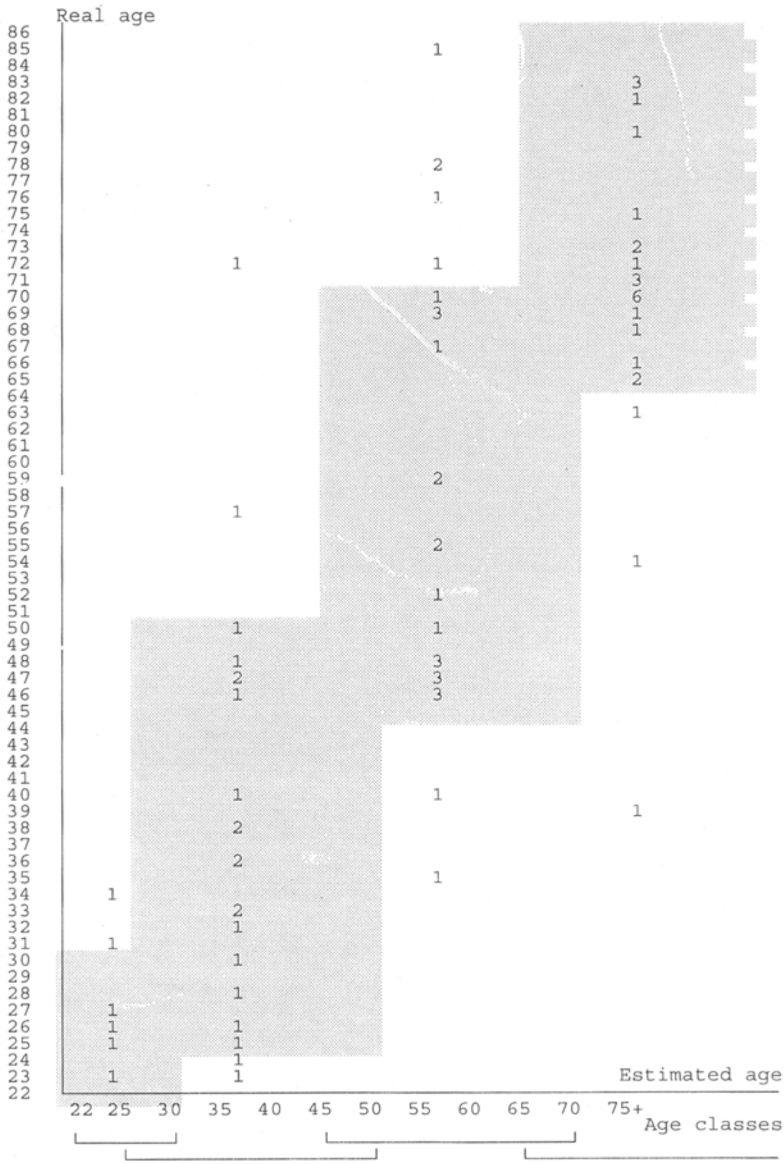

Figure 5 - The real and the calibrated estimated ages of the adult individuals in the identified sample from the Broerenkerk. The shaded areas indicate correspondence.

TABLE 1 - The average differences in the degree of attrition between the first and the second molar, per individual and the quadrant, for the age-related groups of secopnd molars, in a diachronic series of dental samples from The Netherlands.*

		AVERAGE DIFFERENCES IN THE DEGREE OF ATTRITION BETWEEN M1 AND M2 FOR:		
	Date	M2's with attrition 2-/2+ I Diff. (N)	M2's with attrition 3-/3+ II Diff. (N)	M2's with attrition ≥ 4 III Diff. (N)
Broerenkerk Zwolle[1]	< 1800 - 1829 AD	.469 (129)	.492 (62)	.481 (26)
St. Janskerk 's-Hertogenbosch[2]	ca 1775 - 1858 AD	.611 (175)	.688 (58)	.515 (17)
Jobsgasthuis Utrecht[3]	ca 1600 - ca 1800 AD	.681 (130)**	.667 (45)**	.446 (14)
Minderbroederskilooster 's-Hertogenbosch[4]	1300/50 AD - 1600/25 AD	.867 (15)	1.031 (32)	.547 (16)
Engelen, NH kerk 's-Hertogenbosch[4]	13th-16th century AD	.790 (31)	.875 (9)	.300 (5)
Frankenhof St. Antonykapel Wijk[4,5]	ca 850 AD - ca 1700 AD	1.088 (142)	1.157 (206)	.744 (159)
Agnietenklooster Hoorn[4]	ca 1400 - ca 1500 AD	.941 (34)	.956 (45)	.444 (9)
Settlement cemetery Blokhuizen[4]	ca 1000 - 1170 AD	.990 (48)	.990 (49)	.524 (31)
Cemetery on 'De Heul' Wijk bij Duurstede[5,6]	ca 700 - ca 850 AD	.787 (47)	.765 (49)	.575 (30)
Cemetery on 'De Engk' Wijk bij Duurstede[4,5]	ca 700 - ca 850 AD	.936 (78)**	.755 (138)**	.618 (76)
Settlement cemetery Lent[4,7]	630 - ca 750 AD	.762 (42)	.947 (19)	.607 (21)
Cemetery Boschstraat Maastricht[4,8]	6th/7th century AD	1.019 (13)	1.333 (9)	.786 (7)
Late Roman cemetery Nijmegen-Oost[4,9]	end 3rd - end 4rth century AD	.875 (107)**	.524 (41)**	.250 (3)

* Estimation of the average differences between the first and the second molar for the standard scales used in dental aging gives the following results:

	Average difference
Brothwell (1972, 2nd ed.: 69)	.64
Miles (1963: 204)	.61
Miles (1963: Fig. 7/8)	.62
Lovejoy (1985: 49-50)	.61

corrections

	** Mann-Whitney U-tests I/II (Siegel 1956: 116-127; two-tailed probabilities)	Kolmogorov-Smirnov two-sample tests I/II (Siegel 1956: 127-136; two-tailed probabilities)
Jobsgasthuis	Z = 1.475, p = .142	D = .313, .005 > p > .001
De Engk	Z = 2.846, p = .004	D = .302, p < .001
Nijmegen-O.	Z = 5.295, p = .000	D = .539, p < .001

1. This study; Bouts et al. 1992. - 2. Pot 1988b. - 3. Pot et al. 1989. - 4. Pot unpublished material. - 5. Van Es 1990; the cemeteries op 'De Heul' and op 'De Engk' belong to the early medieval town of Dorestad. - 6. Perizonius & Pot 1981. - 7. Van Es & Hulst 1991 - 8. T.A.S.M. Panhuysen 1984: 80, 124-125; R.G.A.M. Panhuysen pers. comm. - 9. Zoetbrood 1985, 1986, 1988, 1990; P.A.M. Zoetbrood pers. comm

TABLE 2 - The composition of the sample of dentitions of identified individuals in the skeletal material from the Broerenkerk.

	Males	**Females**
Children (0-15)	15	9
Adolescents (15-21)	2	3
Adults (known sex and age)	39	48
Adults (known sex, unknown age)	-	3
Total	**56**	**63**

TABLE 3 - The distribution of the aging methods used over the various age classes and the relation between these methods and the percentages of correct classifications.[1]

	Age estimations based on:	
Real age classes	Several indicators including molar attrition	Exclusively PCI-index and alveolar resorption
21 - 25	6	0
25 - 35	18	3
35 - 45	12	15
45 - 55	5	7
55 - 65	0	3
65 - 75	0	7
75 - 85	0	4

	Percentage correct estimations by:	
	Several indicators including molar attrition (N=41)	Exclusively PCI-index and alveolar resorption (N=39)
Prior to calibration	10 (24.4%)	7 (18,0%)
Post calibration	33 (80.5%)	31 (79,5%)

1.Two-sample Chi-square tests (Siegel 1956:104-111, two-tailed probabilities) demonstrate that the distributions of the aging methods over the age classes 21-35, 35-45 and 45-85 differ significantly:
$\Sigma X2 = 26.4790$, d.f. =2, $p < .001$
The aging methods do not differ in their resulting numbers of correct classifications:
$\Sigma X2 = .5052$, d.f. =1,$.50>p>.30$ (prior to calibration);
$\Sigma X2 = .0125$, d.f. =1,$.95>p>.90$ (post calibration).

TABLE 4 - Applicability, accurancy and realiability of four macroscopic aging techniques.
A= the percentage of individiuals which could be investigated by method; B= the overlap between the resulting age classes; C= the percentage of correct classifications; D= the average discrepancy between the real age and the age class to which the incorrectly classified individuals were attributed; an E= the resulting age classes.

Table 4 is presented more clearly in LINK.

NR. OF AGE CL. --- OVER-LAP	FACIES AURICULARIS					SYMPHYSE PUBIS					CRANIAL SUTURES LAT.ANT./VAULT					DENTAL ATTRITION				
	A %inves	B overl	C %corr	D avdisc	E agecl	A %inves	B overl	C %corr	D avdisc	E agecl	A %inves	B overl	C %corr	D avdisc	E agecl	A %inves	B overl	C %corr	D avdisc	E agecl
FOUR --- YES	-	-	-	-	-	25.0%	15 yr.	78.6%	7.8 yr.	19-25 26-50 35-60 49+	-	-	-	-	-	74.1/ 92.2% (of ind./ dent.)	5 yr.	80.0%	male 5.4 fem. 10.2 yr.	22-30 25-50 45-70 >65
THREE --- NO	50.0%	-	67.2%	11.7 yr.	20-49 50-79 79+	25.0%	-	78.6%	14.7 yr.	19-25 26-50 50+	-	-	-	-	-	-	-	-	-	-
THREE --- YES	50.0%	16 yr.	80.3%	12.4 yr.	20-50 40-75 49+	25.0%	15 yr.	85.7%	10.2 yr.	19-29 30-64 49+	-	-	-	-	-	-	-	-	-	-
TWO --- NO	50.0%	-	78.7%	10.5 yr.	20-49 49+	-	-	-	-	-	66.1/ 58.0%	-	85.1/ 81.5%	10.0/ 9.3 yr.	≤35 >35	-	-	-	-	-
	CALIBRATION ONLY BY SAMPLE OF KNOWN AGE															CALIBRATION POSSIBLE WITHOUT SAMPLE OF KNOWN AGE				

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