Attrition – A Criteria in Estimating the Age

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Abstract

Context: With respect to the recognition of an individual in forensic circumstances age assessment is an essential aspect. Teeth are considered to be least destructible part of the body under most conditions occurring in the nature like mass disasters. As the age advances, there will be physiological wearing away of the tooth due to tooth - tooth contacts, as in case of mastication. By knowing the level of attrition, age of an individual can be estimated. Microscopic investigation may not be achievable in certain instances and assessment of age relies on the sole examination of tooth by attrition. **Aims:** The aim of the research was meant to evaluate the age of individuals using Average Stage of Attrition (ASA) and Gustafson's method and comparing efficacy of both the methods. **Methods and Material:** The study sample constituted 60 participants. Dental caries, restored crowns and patients with bruxism were excluded. The patients examined were in the age group of 35-60 years. Scores were evaluated by using Gustafson's method and Average stage of attrition method. **Statistical Analysis used:** Regression Analysis. **Results:** The average stages of attrition and Gustafson's scoring criteria were evaluated by conferring with the graduation standards. The data was collected and regression analyses were carried out for both the methods. By regression analysis, four regression equations for each method were obtained. Evaluation of attrition level and its accuracy in estimating the age by ASA method is more reliable than Gustafson's attrition scoring.

Keywords: Age Estimation, ASA Method, Forensic Identification, Gustafson's Method

1. Introduction

Two important factors of forensic odontology are to determine the age and sex of an individual in mass disasters or in cases of legal disputes. Teeth are considered to be most reliable in the estimation of age because of their changes that are reflected from cradle to the grave[1]. In our body, teeth are the sturdy parts as they can withstand more stress and heat than any other parts and also, their location inside the oral cavity makes them more protective to external assaults in mass disasters.

At first Gustafson (1950) presented a paper where six structural changes of teeth such as attrition, secondary dentin formation, recession of gingiva, cemental apposition, root transparency were used in the estimation of age[2]. Later many authors modified this method [(G. Johanson (1971), V. K. Kashyap, N.R. Koteswar Rao (1990)] and showed better results by using multiple regression analyses[6].

Given the superior preservation of dental tissues and the historic preference of early anthropologists to collect skulls over post cranial elements (walker *et al.*, 1991), the ability to estimate age from the dentition alone can be particularly useful for researchers studying past population.

It is typical to see wide-ranging tooth wear in all primeval civilizations and is considered a chief source of tooth problems[8]. Tooth wear studies centered on skull material of archaeological sites have largely been attributed to dietary variables. The intake of acidic drinks and foods, together with a coarse and abrasive diet, is thought to have had a substantial impact in dental wear[9].

Dental experts can estimate age related pathological changes by examining arthritic changes in TMJ, attritional wear of teeth and root, root dentin translucency[1].

Enamel does not have the potency to remodel and changes once occurred can remain over longer periods. With these changes it can be possible to estimate the age of an individual. Attrition is a physiological wearing of the teeth. At the time of tooth eruption there is no attrition but it becomes evident as the age advances. It may expose the dentin and the pulp cavity. Because microscopic study of teeth is not always attainable, age assessment is based on clinical examination of attrited teeth[5].

Measurements of attrition are considered as parameters for age estimation[7]. Method given by Li and Ji[3] was one of the most reliable methods (ASA). In his method, graduation standard was established by taking consideration of average stage of attrition level of all the cusps.

Aim of this study was to estimate age from ASA method and Gustafson's method by attrition levels and comparing efficacy of both the methods.

2. Subjects and Methods

The study sample constituted 60 participants who came to G. Pulla Reddy Dental College and Hospital. Consent was taken from the participants before clinically examining the attrition level. The age group of participants in this study was 35-60 years. First and second molars from both the maxillary and mandibular arches were taken into consideration. In this study, side differences were not considered although the differences of attrition in respect to both arches were taken into account. This study was purely based on visual examination without any histological or microscopic examination. Age estimation was carried out using ASA method (Figure 1) and Gustafson's method (Table 1).

Exclusion criteria
- Dental caries
- Restored teeth
- Artificial teeth
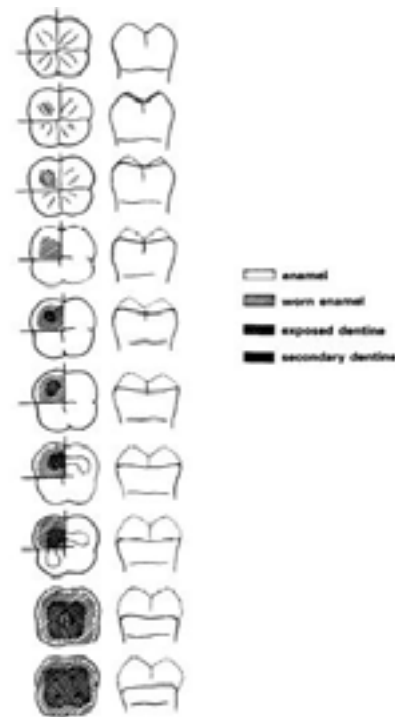
Figure 1. ASA chart by Li and Ji (1995). Represents the attrition stages (0-9) from top to bottom[3].

Table 1. Gustafson's scoring of attrition level

SCORING	LEVEL OF ATTRITION
0	NO PRESENCE OF ATTRITION
1	ATTRITION RESTRICTED TO LEVEL OF ENAMEL
2	ATTRITION LIMITED TO LEVEL OF DENTIN
3	ATTRITION INVOLVING UPTO PULP CAVITY

- Bruxism and other parafunctional habits

2.1 Graduation Standards Described by Li and Ji[3]

Scoring according to ASA method from 0 to 9:

0 – Presence of sharp cusp with no attrition

1 – Slight attrition seen on the ridges and top of the cusp.

2 – Presence of limited oblique facet on the cusp or the cusp may appear obtuse.

3 – Slight or obvious depression of wear facet, and connection of one or more other facets may be noticed with larger portion of the cusp worn away.

4 – Appearance of dentin as a spot (average diameter is <1 mm).

5 – Dentin spot with an average diameter of > 1 mm, and the plane of attrition is equal or sunk intensely.

6 – One spot of exposed dentin will unite with additional one and/or cusp is almost completely worn away.

7 – One spot of exposed dentin unites with two supplementary spots and/or cusp is completely worn away.

8 – Presence of exposed dentin in the form of a circle and an island of enamel similar to star like is seen within it. Exposure of secondary dentin may also occur.

9 – Dentin exposure is seen on the whole occlusal surface along with exposure of secondary dentin.

Scoring of 8 and 9 is done by viewing the whole occlusal surface rather than a single cusp.

3. Results

According to the grading values, the ASA scoring and Gustafson's scoring criteria were evaluated. The data was collected and regression analysis was carried out for both the methods. By regression analysis four regression equations for each method were obtained. Regression equations are shown in Table 2 (ASA) and Table 4 (Gustafson's). For evaluating ASA method, a blindfold test was carried out on ten samples of our study. The results are shown in Table 3. Comparison of Actual age with estimated ages for each molar of both arches is shown in Graph 1 and Graph 2.

4. Discussion

Molar enamel attrition of the entire crown is attributed in the graduation of ASA method[3]. Attrition of tooth cusps may vary. Heavily attrited cusp may estimate the age older. The ASA method, though, considers the average value of the stages of attrition on all cusps of a given molar and overwhelms the insufficiencies of other methods[3]. Tomenchuk and Mayhall in 1979 by measuring the cusp height established that the level of molar wear can be assessed[12]. It was discovered that approximately 30% of male maxillary molars were worn more rapidly than female counterparts. This gender dimorphism in molars wear was attributed to differential bruxism[12]. In present study, it is clear that attrition can be used as a

Table 2. Regression equations for ASA method (Original)

JAW	Tooth	Equation	S.D.	R
Maxilla	First molar	Y = 36.79+3.36M1	1.07	0.21
	Second molar	Y = 34.16+5.49M2	0.76	0.29
Mandible	First molar	Y = 20.75+5.99M1	1.18	0.84
	Second molar	Y = 34.51+4.12M2	0.88	0.21

Here, **Y** is the actual age of the sample, **M1** - Score obtained by ASA method for 1st molar, **M2** - Score obtained by ASA method for 2nd molar, **S.D.** – Standard Deviation, **r**- correlation coefficient
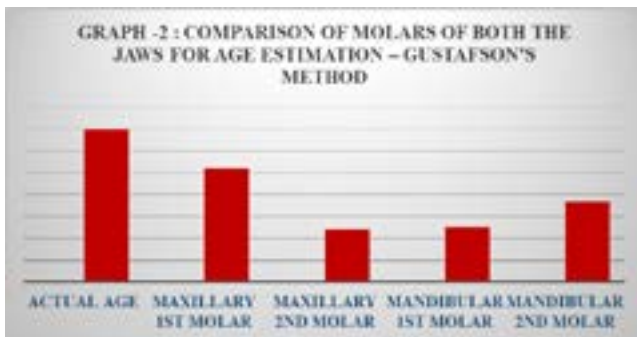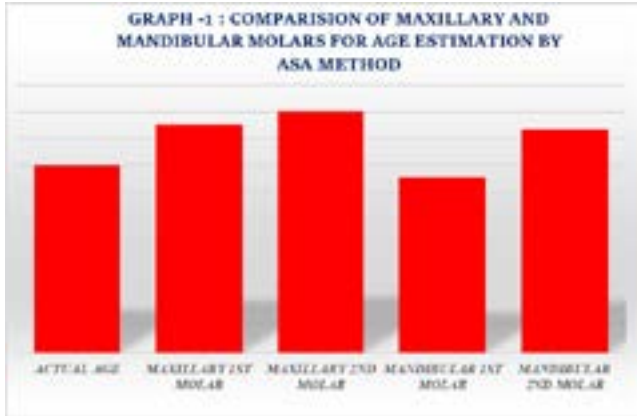
Table 3. Blind fold test for 10 samples by ASA method (Original)

S.NO.	REAL AGE(R)	ASSESSED AGE(A)	A-R
1	35	32.7	-2.3
2	55	56.6	1.6
3	48	43.7	-4.3
4	39	38.7	-0.3
5	60	62.6	2.6
6	53	55.1	2.1
7	50	52.1	2.1
8	44	47.7	3.7
9	42	43.2	1.2
10	37	40.2	3.2
MEAN	**46.3**	**47.26**	**0.96**

Table 4. Regression equations for Gustafson's method (Original)

JAW	Tooth	Equation	S.D
Maxilla	First molar	Y = 37.51+8.47M1	8.45
	Second molar	Y = 39.98+8.89M2	8.9
Mandible	First molar	Y = 28.54+10.28M1	13.2
	Second molar	Y = 34.18+8.61M2	8.61

reliable marker in estimating the age. However, attrition is multifactorial and it is necessary to use appropriate method in estimating the age. In our study we observed that ASA method is more reliable when compared to Gustafson's method. The "r" value (Correlation coefficient) among the stage of attrition (M) and the estimated age (Y) in

GRAPH -1 : COMPARISION OF MAXILLARY AND MANDIBULAR MOLARS FOR AGE ESTIMATION BY ASA METHOD

GRAPH -2 : COMPARISON OF MOLARS OF BOTH THE JAWS FOR AGE ESTIMATION – GUSTAFSON'S METHOD

Figure 2. STAGE – 0 (ASA) (Original).

the Table 2 showed high value for mandibular first molar when compared with others, suggesting that mandibular 1st molar is more reliable. Standard Deviation (S.D.) of estimated age (Y) for each equation in Table-2 (ASA method) has smaller values while in Table 4 (Gustafson's method) have larger values. These results indicate that by using ASA method, the equations determined would estimate a very near actual age if the stages of attrition are

Figure 3. Arrow mark indicating dentin spot> 1mm (Original).

Figure 4. Arrow mark indicating dentin spot <1mm (Original).

determined properly. Correlation coefficient in the paper published by Li and Ji (1995) showed least value of 0.94, but in our study, we got a least value of 0.21. Attrition depends on various factors like gender, geographic location, hardness of the teeth, eating and chewing habits, type of occlusion, the type of food and method of mastication, and existence of artificial teeth, environmental conditions and parafunctions. As this study was carried out in South Indian population, the samples have different food habits like some are vegetarian and some are non-vegetarian. Moreover, the dietary composition of population studied

Figure 5. Lingual cusps lesser attrition when compared to buccal cusps (Original).

Figure 6. It is a mandibular 1st molar, here the arrow marks indicate the exposed dentin. By graduating score by average stage of attrition, if we enter 4.75 in the equation $Y = 20.75 + 5.99 \times 4.75 = 47.7 \pm 1.18$ years. The actual age is 45 years. (Original).

Figure 7. For the same mandibular 1st molar, by Gustafson's attrition criteria; $Y = 28.54 + 10.28 \times 2 = 49.1 \pm 13.2$ Years. Actual age is 45 years. (Original).

by Li and Ji had steaming as a common manner of food preparation. In our study population, coarse diet is also followed by some of the samples.

5. Conclusion

In some aspects, age estimation is not applicable by microscopic examination of teeth, and then it is often determined by the grade of attrition related with the tooth. It is necessary to do more studies on different populations in different regions by including a large sample to get more accurate and efficient results for the estimation of age by ASA method. In carious teeth and restored teeth, the evaluation of attrition for estimating the age may vary. More studies should be conducted on ASA method to evaluate the efficacy in different large populations and to get more accurate result even from a single molar tooth by including factors like chewing habits, type of occlusion and other dietary habits.

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