Reliability Comparison of Two Forensic Dental Age Estimation Methods

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Abstract:
Aim*: Our aim was to compare reliability of Gustafson´s and Johanson´s method of forensic age estimation in extracted thirds molars.*
Material and Method*: 42 ground sections of third molars were evaluated according to Gustafson´ s and Johanson´s method. Patient´s age and gender was registered at time of extraction of third molar. We evaluated level of attrition, secondary dentine deposition in pulp, changes in periodontium, cementum apposition, and root resorption and root translucency. Each factor was alloted a score regarding degree of changes in the tooth. Total score was calculated and transferred to the estimated age according to Gustafson´s and Johanson´s formula. A mean difference of 5.38 and 4.97 years was obtained with Gustafson's formula and Johanson´s formula, respectively.*
Conclusion: *Despite of the variability of third molars, we found a significant correlation between estimated Dental age and chronological age of an individual. Johanson´s method proved to be more reliable than Gustafson´s method.*
Keywords: *Age estimation; Forensic odontology; Third molar; Gustafson´s formula; Johanson´s method*

I.   Introduction

One of the important application of forensic science is identification of the dead person by means of teeth. Teeth are considered to be a reliable identification factor as they belong to the most resilient substances of human skeleton**[1-4].** Therefore, dental age estimation techniques are of paramount importance in forensic practice routinely. Gustafson (1950) **[5]** devised age assesment method estimating six physiological variables according to his four point system. His method combined scores from measurements of attrition, periodontitis, secondary dentine, cementum apposition, root resorption and root translucency. Johanson (1970) **[6]** tested Gustafson's method on a larger, independent sample. His method evaluated the same six age related changes as Gustafson, but scored them by enlarged seven point criteria system. He also used multiple regression to calculate a regression line from which ages for unknown individuals could be estimated .

Most authors dealing with dental age estimation issue commonly excluded third molars from their studies because of its variability. Nevertheless, in last years third molars have been found very usefull in age estimation of adolescents as they are the only developing teeth after fourteenth year of age. **[7-8]**

The aim of our study was to compare chronological age with estimated dental age by evaluating physiological parameters of third molars according to Gustafson´s and Johanson´s dental age estimation techniques.

II.   Material And Methods

A total of 42 third molars were extracted at the Department for Oral and Maxillofacial Surgery, University Hospital Olomouc, Czech Republic. At the time of extraction age of the patient, gender and number of tooth was recorded **(Table 1).** The known age was ranging from 17 to 63 years with average age 26.2 years.

Every tooth was after extraction cleaned under running water, disinfected in 3% H_2O_2 and dried at the room temperature. Each of them was subsequently embedded in alabaster plaster type II. Further processing was carried out with dental saw (Trystom Olomouc) and then with rough carborundum stone until a section of 1 mm was obtained **(Figure 3)**. The root translucency was noted at this thickness. Finally, cleaned and dried section was viewed under microscope.The following six dental parameters were studied in each case according to Gustafson´s and Johanson´s criteria **(Table 2).**

Table 1 Distribution of gender and type of tooth

	18	28	38	48	TOTAL NUMBER
FEMALES	3	9	6	15	33
MALES	1	2	1	4	9
TOTAL NUMBER OF CASES	4	11	7	19	42

Table 2 Gustafson´s and Johanson´s classification of physiological changes\

	Gustafson´s classification (Figure 1)	Johanson´s classification (Figure 2)
Attrition	A0 - No attrition	A0 - No attrition
	A1- Attrition limited to enamel level	A0,5 – Minute attrition
	A2- Attrition limited to dentine level	A1- Attrition half of the enamel thickness
	A3 - Attrition up to pulp cavity	A1,5 – Thin layer of enamel
		A2 – Dentine has been attrited to a small extent
		A2,5 – Attrition has reached halfway throught the dentine
		A3 - Attrition up to pulp cavity
Periodontal	P0 - No obvious periodontal disease	P0 - No obvious periodontal disease
	P1 - Beginning of periodontal disease but no bone loss	P0,5 – Small retraction from the cemento-enamel junction
	P2 - Peridontal disease more than 1/3rd of the root	P1 – Retraction of about 2 mm
	P3 - Peridontal disease more than 2/3rd of the root	P1,5 – Retraction of 4 - 7mm
		P2 – Retraction of 10 mm
		P2,5 - Retraction of 15 mm
		P3 – Only millimeter of the root is surrounded by a periodontium
Secondary	S0 - No secondary dentine formation	S0 - No secondary dentine formation
	S1 - Secondary dentine up to upper part of pulp cavity	S0,5 – Some secondary dentine formation
	S2 - Secondary dentin up to 2/3rd of the pulp cavity	S1 - Secondary dentine up to upper part of pulp cavity
	S3 - Diffuse calcification of entire pulp cavity	S1,5 – Secondary dentine up to mid part of pulp cavity
		S2 - Secondary dentine up to 2/3rd of the pulp cavity
		S2,5 – Almost complete calcification of pulp cavity
		S3 - Diffuse calcification of entire pulp cavity
Root translucency	T0 - No translucency	T0 - No translucency
	T1 - Beginning of translucency	T0,5 – Very small layer of translucency
	T2 - Translucency more than 1/3rd of the apical root	T1 - Beginning of translucency
	T3 - Translucency more than 2/3rd of the apical root	T1,5 – Translucency to the 1/3 of the apical root
		T2 - Translucency more than 1/3rd of the apical root
		T2,5 – Translucency almost reached 2/3 of the apical root
		T3 - Translucency more than 2/3rd of the apical root
Cementum	C0 - Normal cementum	C0 - Normal cementum
	C1 - Thickness of cementum more normal	C0,5 – Thicker layer of cementum
	C2 - Abnormal thickness of cementum near the apex of the root	C1- Thickness of cementum more normal
	C3 - Generalized abnormal thickness of cementum throughout the	C1,5 – Bigger layer of cementum
		C2 - Abnormal thickness of cementum near the apex of the root
		C2,5 –Localized abnormal thickness of cementum
		C3 - Generalized abnormal thickness of cementum through the apex
Root resorption	R0 - No resorption	R0 - No resorption
	R1 - Spotted resorption	R0,5 –Small resorptions on only one place
	R2 - Resorption limited to cementum	R1 – Resorption in 2 or more places
	R3 - Extensive resorption of the cementum and dentin	R1,5 – Extensive resorption
		R2 – Deep and wide resorption
		R2,5 – Resorption over the whole surface
		R3 - Extensive resorption going into the dentine
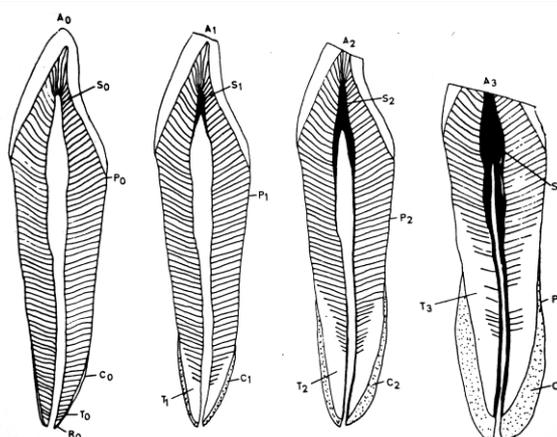
Figure 1 Schematic drawing of Gustafson´s four point system [5]
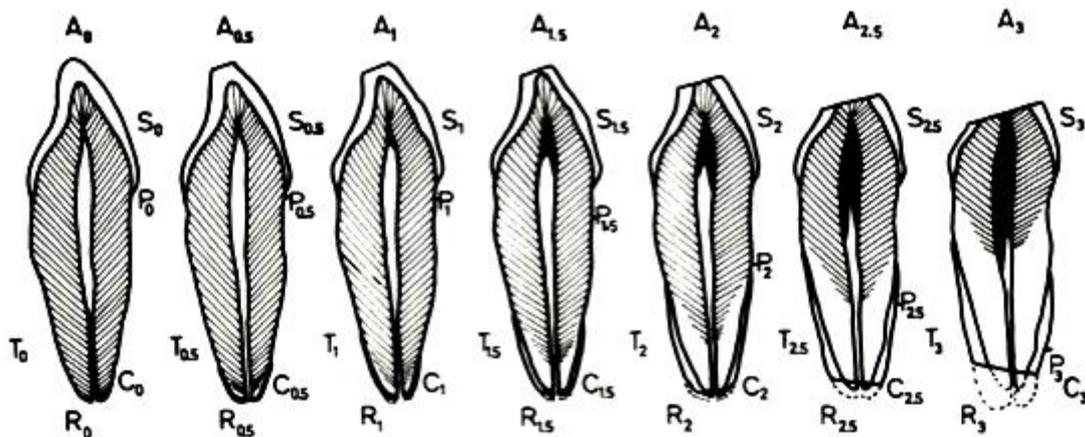
Figure 2 Schematic drawing of Johanson´s seven point system **[6]**

Figure 3 Example of evaluated specimen of third molar ground section

III. Results

After evaluation of the physiological changes as mentioned above, we estimated age according to formula devised by Gustafson and Johanson:

Gustafson´s formula: $Y = 11.43 + 4.56X$.

Johanson´s formula: $Y = 11.02 + 5.14A + 2.3S + 4.14P + 3.71C + 5.57R + 8.98T$, where Y = estimated age,

$X = A + S + P + C + R + T$, A = attrition, S = secondary dentin, P = periodontal disease, C= cementum apposition, R = root resorption, T = root translucency.

A graph was plotted with actual age on one side, the score calculated on the other for each method **(Figure 4, 5)**. Mean error of 5.38 years and 4.97 years was achieved with Gustafson's and Johanson´s formula, respectively.
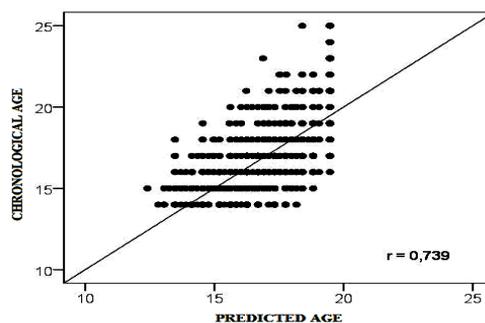

Figure 4 Correlation between total score and chronological age using Gustafson´s formula
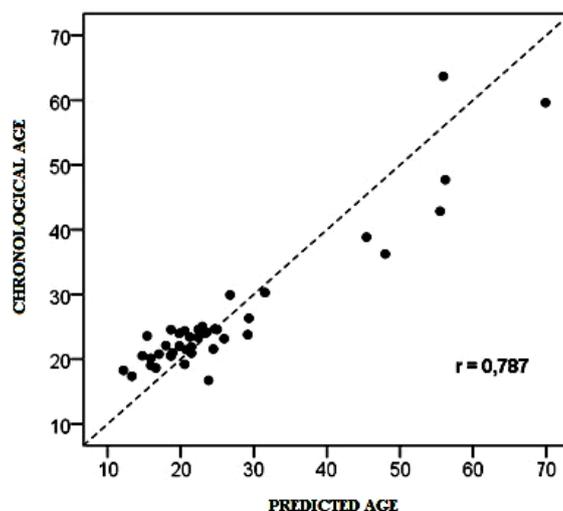
Figure 5 Correlation between total score and chronological age using Johanson´s formula

IV. Discussion

In our study Johanson´s method of age estimation achieved better results than Gustafson´s method by 0.41 years. This might be caused by different approach of Johanson´s methodics in which he performed a multiple regression of age against a refined scale of the six parameters used by Gustafson. **[9]**

Johanson also proposed that the ideal thickness of ground section should attain 0,2 mm. Nevertheless, it has been proved that the conception of using less thick section up to 0.25 mm does not yield better results. **[10]**

The standard error of calculated age by Gustafson´s method was in our study 5.38 years, which was contrary to the original finding of Gustafson who found age difference of 4.5 years. Although this result suggest that the third molars are not the ideal teeth for age estimation, there was still proved quite signifiant correlation.

On the other hand, the standard error of calculated age by Johanson´s formula in our study was 4.97 years. This result is even better than original research, where Johanson calculated an error of 5.16 years. This outcome indicates that use of third molars might be very promising.

Nevertheless, further research of this field with larger number of specimens is still required.

V. Conclusion

Despite of the variability of third molars, we found a significant correlation between estimated dental and chronological age of an individual. Johanson´s method proved to be more reliable that Gustafson´s method.

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