

Short communication

Dental age estimation, quality assurance and age estimation of asylum seekers in Norway

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Abstract

The historical development of age estimation and the different techniques are presented. Also it is important to separate individuals below 20 years where tooth development can be used and those above 20 years of age where regressive changes must be used and where the visual assessment may be more important. The recommendations for quality assurance from the International Organization for Forensic Odonto Stomatology (IOFOS) is discussed and also the problems of quality assurance on an international level. Suggestions for changes in these recommendations are presented. Finally the Norwegian dental age estimation project in asylum seekers who claim to be below 18 years of age is described.

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1. Introduction

Dental age estimation can be divided into two periods in life. The first period is when the teeth are developing in the jaws up to 20 years. Comparison of the developmental stages with tables for the different stages may here be used as a scientific statistical method. Later, when all teeth are fully formed regressive age related changes might be used as a scientific method. Such methods are less accurate than methods based on the developmental stages.

Dental age estimation may be performed both in living and dead persons. The same methods may be applicable. However for dead persons it is rarely possible to get any information about the living conditions and diseases of the individual. In addition, the teeth may be extracted and ground according to the different techniques for more accurate studies.

An examination of the mouth and the dental conditions is an integrated part of age estimation in both living and dead persons. Such an examination should end with a visual assessment of the age of the individual. In many identification cases where we have good dental records the age estimation is of less importance. Thus a visual assessment may be enough. However, in cases where the age estimation

may be greater importance, at least two scientific methods should be used.

2. Age estimation of individuals below 20 years of age

Most scientific studies have been aimed at the construction of developmental tables for the different stages of tooth formation and how fine these stages can be graded without being imprecise and difficult to determine.

Generally, only studies made after 1960 have sufficiently large material and fine grading so they should be used to calculate the age of the individual. These methods, based upon the developmental stages, are more accurate than age estimation based on the stages of eruption of teeth. Therefore, visual age assessment methods have not often been performed in these age periods and the trust in the statistical scientific tables has been strong.

However, the dental development may be retarded by severe and long lasting diseases. This may also be the case in many congenital syndromes. Only rare hormonal hyper secretion may accelerate the development. Also nutritional deficiencies may retard the dental development. Severe dental diseases and tooth extraction may also influence the dental development. For a most accurate assessment of the age it is necessary to assess these factors and take them into consideration.

In Norway we are using at least two different age estimation techniques in cases of age estimation in individuals below

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20 years of age. Generally we are using the tables from Finland of Haavikko [1] and from Canada by Anderson et al. [2]. The tables from Sweden by Kullman et al. [3] and from South Africa by Harris and Nortje [4] are often consulted when having to estimate the age of Caucasians or Negroids, respectively, based upon the development of wisdom teeth.

3. Age estimation of individuals above 20 years of age

In dental age estimation of individuals above 20 years scientific methods must rely upon regressive age changes such as attrition, loss of periodontal attachment and secondary dentin formation. Such parameters are partly influenced by function and also by pathologic processes and are thus far less accurate compared to the developmental stages of the teeth. Thus, in these cases the visual assessment may be almost as accurate as the calculated age according to a specific technique. A visual assessment may thus be an important supplement to scientific methods.

The first scientific technique for age calculation in adults was presented by Gustafson [5]. It was based on longitudinal sections of teeth cut through the central area. It can not be used for living person, only in dead when extraction of a tooth is allowed. The technique consisted in attributing scores from 0 to 3 for the presence and amount of age related changes such as attrition, periodontal ligament retraction, secondary dentin formation, root translucency and root resorption. The scores were added and a regression analysis with age as dependent variable was performed.

Later his method has been modified by several researchers such as Dalitz [6], Bang and Ramm [7], Johanson [8], Maples [9], Solheim [10,11] and Kvaal et al. [12]. Gustafson's optimistic standard deviation of ± 3.4 years has never been confirmed and may be based on wrong statistics [5]. Also Johanson's standard deviation of ± 5.6 years seems to be too optimistic [8]. Investigation have shown that a standard deviation of around ± 10 years is normal for most methods [13].

All these formulae are based upon regression analysis e.g. multiple regression with age as dependent variable and the different age related changes as independent variables. The formulae are generally most accurate around 40–50 years and with increasing inaccuracy in younger and especially in older age groups. Also another difficulty is that there is a pronounced tendency for overestimation of younger persons and underestimation of older persons. These facts must be taken into consideration when making the final conclusion.

In living persons, it is not possible to extract teeth and grind them according to the different techniques. Thus a radiologic technique like the one developed by Kvaal et al. [12] is one of the few that can be used. It is based only on the size of the pulp in relation to the whole tooth and gives a measure of the secondary dentin formation. However it is partly dependent on the anatomy of the tooth and pulp. Formulae exist for each of six different teeth. To reduce the effect of unusual anatomy of one tooth the results becomes more accurate if three teeth in the maxilla and the mandible respectively are used, or even better

when all six teeth are used in one formula. In these cases the individual rather than the tooth is the unit.

An alternative morphologic technique in living persons is the morphologic technique by Solheim [11]. This technique is based only upon attrition, colour and recession of the periodontal attachment, all variables that can be assessed in a living individual. This method is almost as good as the morphologic technique based on sectioned teeth [10]. Especially for maxillary second premolars it is very accurate and produces a strong correlation with age ($r = 0.88$).

For most methods of age calculation there is only one regression formula that is used for all types of teeth. This is obviously inaccurate as teeth emerge in the oral cavity at different times. Also the contribution of different types of teeth in chewing vary and thus the expected changes. We therefore hold that the best method should have one formula for each type of tooth.

It is difficult to collect extracted teeth to be used as material for methods of age calculations. Therefore, for some methods more than one tooth from the same individual has been used. For others the material is not described accurately enough so that the use of only one tooth from each individual can be verified. It may be obvious that the variation within one individual is less than between different individual. Thus this may result in a too small standard deviation and it may look like the method is more accurate than it really is.

4. Quality assurance in age estimation

In most countries systems for quality assurance are more or less obligatory or imposed by law. Systems for quality assurance in forensic odontology are being developed. For example for a laboratory to be accredited, systems for quality assurance must have been established. The techniques of forensic odontology are universal. However, nothing had been done until recently to establish systems for quality assurance, which could be applied internationally.

IOFOS took in 2002 the initiative to try to establish a set of steps for quality assurance in forensic odontology, also in age estimation. The set was designed in the way that steps to be observed in a case are given. However the exact technique to be used is not stated and may be subject to further quality assurance by national societies of forensic odontology.

It is difficult to agree upon the various steps as became apparent in the Lillehammer meeting 2004. It was a meeting of a number of experienced forensic odontologists from three continents with the aim of drafting guidelines for quality assurance also in age estimation. As a compromise the various procedure steps were divided in such where there is agreement that they are necessary. They are written in black in the text in IOFOS home page. Other steps, which some think are necessary but others feel are irrelevant, are marked blue in this text. An amazingly number of steps are blue in the text revealing considerable disagreement on both the purpose of the age estimation and the steps to be followed. Basically, the disagreement was between those that only want to apply a statistical method and report the results and those who want to

express the expert's opinion based on his own opinion after taking into consideration the person's living conditions such as diseases and nutrition, clinical findings and of course also the results from scientific statistical methods.

These recommendation should be general for all age estimation whether in young or old individuals, whether in dead or living persons. Of course questions and obtaining background information is impossible in dead persons. Thus these parts are not applicable in dead persons, but considering the possibilities might help in certain cases.

The intention of this paper is to describe the system for quality assurance in age estimation and also suggest for IOFOS some improvements.

5. IOFOS' recommendation for quality assurance in age estimation [14]

A short description of the recommendations is given and the importance of some of the steps discussed. Also the different attitudes towards the role of the expert will be discussed. The recommendation must also be seen in connection with the recommendation for a written report from a forensic odontologic expert. Special requirements for writing the report are not given here. In the following the recommendations are given in italics.

The purpose of the age examination is to:

1. estimate the most likely age of the individual;
2. make reference to the methods used.

All agreed on these steps. These are the more mechanical looking up a stage in a table or apply a formula. There is no assessment by the expert in this and the age estimation could in fact be done by anyone. There is no requirement of stating a standard deviation or confidence interval. It would always be incorrect as it is only valid for the individuals the method is based upon. We should never give any wrong figures in our reports and especially when it comes to statistics. However, the figures for the distribution of the data must only be taken as indicative for the real variation in the actual population.

As optional steps were that the purpose also is to:

3. express the likelihood of an official age, if it exists;
4. express the likelihood of an alternative age if it exists.

If the commission is given by the police they will ask explicitly for what they want to know. However others like private persons or schools, etc. do not know what to ask for. In my mind it is self evident that we have to take the official age and the alternative age into consideration, instead of just saying something about the standard deviation. We should express the likelihood of these two ages and if one can be excluded. If we do not do this, it is left to lawyers to argue without proper statistical understanding. The question is, however, whether forensic odontologists have sufficient understanding of statistics.

Optional is also the way of arriving at the final estimate by using:

1. the expert's own assessment;
2. information from the person on the living conditions and diseases;
3. the results from scientific statistical methods.

As some dentists are not interested in background information the collection of these are also optional. They should be: family economy, food supply, water supply, serious diseases, previous dental problems and treatment, dental hygiene.

There was only agreement on checking the identity of the examined person during the clinical examination. Evaluating the oral mucosa and describing the dentition as far as occlusion, teeth present in the mouth, individual characteristics of the teeth, degree of attrition, colour of the teeth, staining and calculus, periodontal conditions and visual age assessment, solely based upon the teeth, are optional.

It was agreed to carry out a radiographic examination which should include radiographs that may enable the age estimation methods decided upon and which should describe the dentition and individual characteristics of the teeth. It was also agreed to use as many appropriate parameters as possible, to use methods as originally described in the literature and to use as many teeth as possible. Using at least two independent statistical methods was left as an option. Finally the conclusion should end with a complete assessment of the most likely chronological age.

As some of the participants would not make a clinical assessment nor ask for background factors, they had naturally difficulty with taking these factors into consideration in the final assessment of the age. The optional factors were:

1. assess if the methods are appropriate in relation to the individual;
2. assess factors which may have influenced the tooth development or ageing;
3. assess especially if pathologic factors or other may have influenced the findings.

6. Suggested modification of the recommendations

It should be clear if you examine those optional factors, they should be taken into consideration for the final examination. As of today I think we have to accept that a number of experts do not want to exert their work as experts and express their own opinion. Therefore these factors must remain optional.

Maybe the various steps should be numbered consecutively or each subdivision given a number 1, 2, 3, etc. This would immediately make clear which section one is referring to.

It is necessary in some way to express the statistical variation. We feel standard deviation is not the best way and may be inappropriate and incorrect. Confidence interval could be better but will also be incorrect. In these cases we leave to the authority or lawyers to draw the final conclusion from our estimate in the actual case and we feel that if the expert has

problems, it may be even more difficult for a lay person to do this. Thus in the name of justice we suggest that no 3 and 4 under the purpose of the examination are included as obligatory steps. Of course obligatory steps may be excluded in a case, but it requires an explanation. I suppose it is not difficult to find this if an expert thinks this step is irrelevant in the actual case.

Regarding which information should be used for the final conclusion, it seems self-evident that results from statistical scientific methods must be included as obligatory. What else would an expert base his opinion on?

The background information has to be optional as also the clinical examination. However it is difficult to control the identity if the person is not present. In our mind we think why not make a clinical examination, which does not take so much time. At least you could prevent that an obvious wrong calculation from a table or formula is accepted.

Under methods we can only see the advantage and strength in using two independent statistical methods as background for the conclusion and want to include that as obligatory. It says if possible and thus if for some reason it is impossible it can be omitted.

Under evaluation we also will claim that a critical attitude to the method used in relation to the case or individual is necessary and can cause serious trouble if omitted. Thus we will include that as obligatory.

The main topics are extended with one on quality assurance. This can be inserted before the evaluation. We suggest the following.

6.1. Quality assurance

The recommendations of IOFOS should be followed: a statement of that should be included in the report. In addition, two forensic odontologists should cooperate in order to perform the age estimation. The second forensic odontologist does not need to examine the patient. He should though examine the radiographs or preparations and, if deemed necessary, redo the examinations. The second dentist should read the report and suggest corrections. Also he should agree to the exact conclusion and his signature in the report is necessary. These steps should in our mind be obligatory if we take the requirements for quality assurance seriously.

6.2. Dental age estimation of persons claiming to be below 18 years of age applying for asylum in Norway

In the fall 2002 it became clear to the Norwegian Directorate of Immigration (UDI) that too many young people came to Norway claiming to be below 18 years, but many were obviously older. In other countries, like Sweden and Denmark, the authorities had controlled the age of such asylum seekers for years and they had far less people in this category. UDI decided to ask for estimate the age of the asylum seekers when their given age is questioned using teeth and the wrist radiographs.

The Faculty of Dentistry in Oslo was approached with the question if we could do this examination. It was however at that

time a big project with at least 20 examinations per week. The faculty responded positively and after some time, when the examinations had to be done in private practice, the Faculty of Dentistry did all examinations from August 2003. It is done by three different experienced dentists in the children's department. The reports and the radiographs are examined by a second dentist who also must agree to the conclusion.

The number of examinations has dropped from the initial 20 per week to now about 5 per week. It is more than the general decrease in the number of asylum seekers. Probably because we examine the age of those where there is suspicion that they may be older than 18 years. Also in the beginning there were several persons who were estimated to be about 35 years. Now most are about 20 years or below and a few are estimated to be about 25 years. Obviously older persons are not attempting to claim to be below 18 years.

6.3. Are IOFOS recommendations feasible in daily routine practice?

We believe we follow the IOFOS recommendation in most steps. This shows that these are practicable. Also it is a great advantage when there is discussion and doubt about our methods.

6.3.1. Background information

These are difficult to obtain from persons who speak neither Norwegian nor any other European language. In the beginning we had severe difficulty in getting any reliable information from the asylum seekers. Now these questions are included in the first interview at UDI with an interpreter in the asylum seeker in his own language. When he comes for the dental examination the information is present written on a paper. Sometimes we could have wanted to explore some information more accurately, but this is often not possible if the person cannot speak English.

6.3.2. The clinical examination

The identity is controlled by an identity card with picture, which the person is given when he is registered as asylum seeker. Sometimes the person has forgotten this card. We then take a Polaroid picture of the face, which later is included in the report. In addition, the person who accompanies the asylum seekers from the asylum camp has to verify the identity.

We then examine the oral mucosa and the teeth just as described in the optional part of the recommendation. Major caries and restorations are also registered. The degree of attrition and colour are scored according to specific systems. Finally, the clinical examination ends in a visual assessment of the age based on the teeth.

6.3.3. The radiological examination

Before the clinical examination an OPG and one or two periapical exposures on dental films are taken of the maxillary front teeth. After the clinical examination they are studied and characteristics described. Then the age of the individual calculated either from the development of the teeth in young

persons or the dimensions of the pulp chamber and canal in adults. For the development two or three methods are always used and if possible all four wisdom teeth are assessed independently.

If the person is above 20 years and all teeth are fully formed, we are only using the method of Kvaal et al. [12] and generally just on one tooth. The results are used only as an indication as this method as well as other methods based on multiple regressions tends to overestimate the age in young individuals. The main purpose of age estimation in these asylum seekers allegedly below 18 years of age is to prove without doubt that they are above 18 years of age.

There are also a few methods available which can be used for living adults. The method for living persons by Solheim [11] relies much on the colour of the teeth. However it is possible that non-Caucasian people may have more white teeth so we have not used this method.

6.3.4. Evaluation

Before the final estimate of the age is given, we assess if the findings may modify the final estimate because they may have influenced the speed of the tooth development. However the final estimate will be heavily based on the calculated ages according to different method. As these age estimations are done routinely, we do not evaluate the methods in relation to the individual as specified in the recommendation by IOFOS. We are aware of these problems and are using the table for coloured people from Africa [4] in cases of black asylum seekers from Africa. Our opinion is that the ethnic differences means less than the individual variation and it may only be months around the time for completion of the roots of the wisdom teeth.

In accordance with the recommendation, the final estimate is a complete assessment of all facts in the case and gives the most likely chronological age. We never give an estimate of an interval like 18–20 years. We would then say approximately 19 years.

Also we assess the likelihood that the asylum seeker is below or above 18 years of age and sometimes exclude that they are below. The likelihood or possible exclusion of their given age is also assessed.

7. Final remarks

We believe that this is the way to go for international guidelines on quality assurance in forensic odontology and in age estimation in particular. Steps to be observed should be specified on an international level and the exact technique to be used at each step should be left to the national societies. We have shown that this type of quality assurance is practicable in our age estimation of asylum seekers. We have also suggested a few improvements in the recommendations with due consideration to those who do not want to make any expert assessment, but confine themselves to reporting the result from a table or a formula.

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