Agenesis of third molar teeth delays the mineralization of the remaining third molar teeth

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Abstract

Introduction

The purpose of this study was to evaluate if agenesis of one or more third molars would delay the development of the remaining third molars (1-3), and if the agenesis influence the dental age estimation. Lastly, we wished to explore if the present methods are accurate.

Methods

Dental panoramic radiographs from 2008-2015 of 210 patients, who turned 18 years the calendar year the OPGs were taken at The Faculty of Dentistry in Oslo, were divided into two groups consisting of one control group (105 individuals), where none had agenesis, and one test group (105 individuals), where the individuals showed agenesis of one or more wisdom teeth.

Scoring systems of tooth development by Moorrees, Fanning et al. (1963), and Demirijan et al. (1973) were used on the third molar present, and converted to age assessment by tables published by Haavikko (1970), Liversidge (2008), and Mincer et al. (1993).

Results

The majority of the test group had agenesis of two teeth (55%), 40% had agenesis of one tooth and only 5% had agenesis of three teeth. The test group was not subdivided.

When comparing the two groups according to both Demiirjan et al. and Morrees and Fanning et al., the distribution in dental development is delayed in the test group. Examination of wisdom teeth in this group resulted in several teeth in early root development stages, whilst in the control group they were in late root developmental stages. The majority of examined tooth in this group were teeth with fully closed apex or in the final root development stage.

Conclusion

Agenesis of third molars results in delayed mineralization of the remaining third molars, and there were no difference using tables by Liversidge or Mincer to estimate age.

Introduction

Dental agenesis or congenitally missing teeth is the most common oral developmental disorder. Agenesis is a condition where one or more of the primary and/or permanent teeth have not developed. The average person with agenesis is missing one or few teeth, but it is possible to lack as many as six teeth. Lacking more than six teeth, excluding the third molar, is termed oligodentia. [Tallón-Walton et al. 2007]

External factors like pollution or cancer therapy may result in developmental disorders or agenesis in the dentition. However, genetic factors are regarded as the main reason for these conditions. [Tallón-Walton et al. 2007, Kettunen et al. 2005]. Significant differences occur between genders and different ethnic groups. The prevalence of agenesis in the permanent dentition, excluding the third molars, varies from 2, 2% to 10, 1%, and is highest among women [Polder et al. 2004]. The third molar, the second premolar and the maxillary laterals are the most frequently affected. These teeth develop last in their tooth series.

Agenesis of the third molar teeth is the most commonly diagnosed developmental disorder. [Tallón-Walton et al. 2007, Aasheim and Ogaard.1993]. Studies have shown that approximately 20% of the Caucasians are missing one or more third molars [Grahnen 1956, Haavikko K.1971], and only 2% of black Africans are affected in the same way. [Mincer et al. 1993]. This demonstrates the large variations between different ethnic groups. Some dental clinicians claim that the number of dental agenesis has increased through the last decades. [De Coster et al. 2001]. However, it is not proven if the increase of dental agenesis is a result of the evolution or a result of more thorough screening of dental developmental disorders.

When the chronological age is unknown, age may be estimated from development of teeth and/or bone or by degenerative changes in these. Chronological age is different from biological age and consequently age estimation from tooth development is not a precise method to estimate chronological age. However, combined with other age estimation methods, age estimation from dental development may contribute to a more accurate age determination. It is important to be aware of the factors that influence age estimation, so that the methods used to estimate age are as close to chronological age as possible. Studies have shown that agenesis delays mineralization of other teeth in the dentition [Baba-Kawano 2002], and this might include mineralization of the third molar. A late formation of the lower third molar will result in a late formation of the upper teeth. The formation of the other teeth is even later in individuals with missing lower third molars [Baba-Kawano 2002].

Age estimation is used for identification of both deceased and living people with unknown or disputed age like asylum seeking children, in human trafficking, child labor, youth sport etc. To estimate age require knowledge of the factors which might have influence on the different methods and age stages.

Aim

The aim of the present study was to find out if:

1. The development of the remaining third molars (1-3) are delayed when there are agenesis of one or more third molars

2. The agenesis influences the dental age estimation.

Through this study, we wished to explore if it is necessary with more research in this field, and if the present methods are accurate.

Ethical approval

Ethical approval has been obtained from The Regional Committees for Medical and Health Research Ethics (REK) dated 01.06.15 (2014/2235 REK sør-øst B).

Materials and methods

This study reviewed dental panoramic radiographs (OPG) from patients who have attended the Institute of Clinical Dentistry, The Faculty of Dentistry in Oslo. It was a retrospective study and the radiographs have been taken for other clinical reasons.

The material consisted of OPG from individuals who turned 18 years in the calendar year the OPGs were taken. A list of all 18 years old individuals of whom a radiograph had been taken from 2008-2015 was obtained from the patient register. Using the excluding and including criteria listed below we ended up with 210 individuals.

The exclusion criteria used were as follows:

- The overall radiographic quality was poor
- The position of the third molar tooth/teeth prevented visibility of the root development
- Patients affected by oligodentia
- Patients with cleft lip and/or cleft palate
- Patients who lacked any other teeth apart from the third molar teeth, where the reason was

unknown

The electronic dental records were used to retrieve the OPGs. The supervisor, the project leader and the study group had access to these records through an identification number (hospital record number).

The selection of OPGs was separated into two groups;
- The first group consisting of radiographs from 105 individuals which did not have agenesis of any teeth in the permanent dentition, termed the "control group"
- The second group consisting of radiographs from 105 individuals that showed agenesis of one or more third molar termed the "test group".

The third molar present were scored based on diagrams of tooth development that are used in age estimation (see below), and estimations of age was found in different tables. The difference between the dental and chronological ages was calculated and the control and test groups were compared.

Two scoring systems were used:

1. Moorees, Fanning et al. [Moorrees, Fanning et al. 1963]

From these scores age estimates were calculated using tables published by Haavikko [1970] for age estimation of the upper molar and Liversidge [2008] for estimation of the lower third molar.

2. Demirijan et al [Demirijan et al 1973]

The scores according to Demirijan were used with the tables made by Mincer et al [1993].

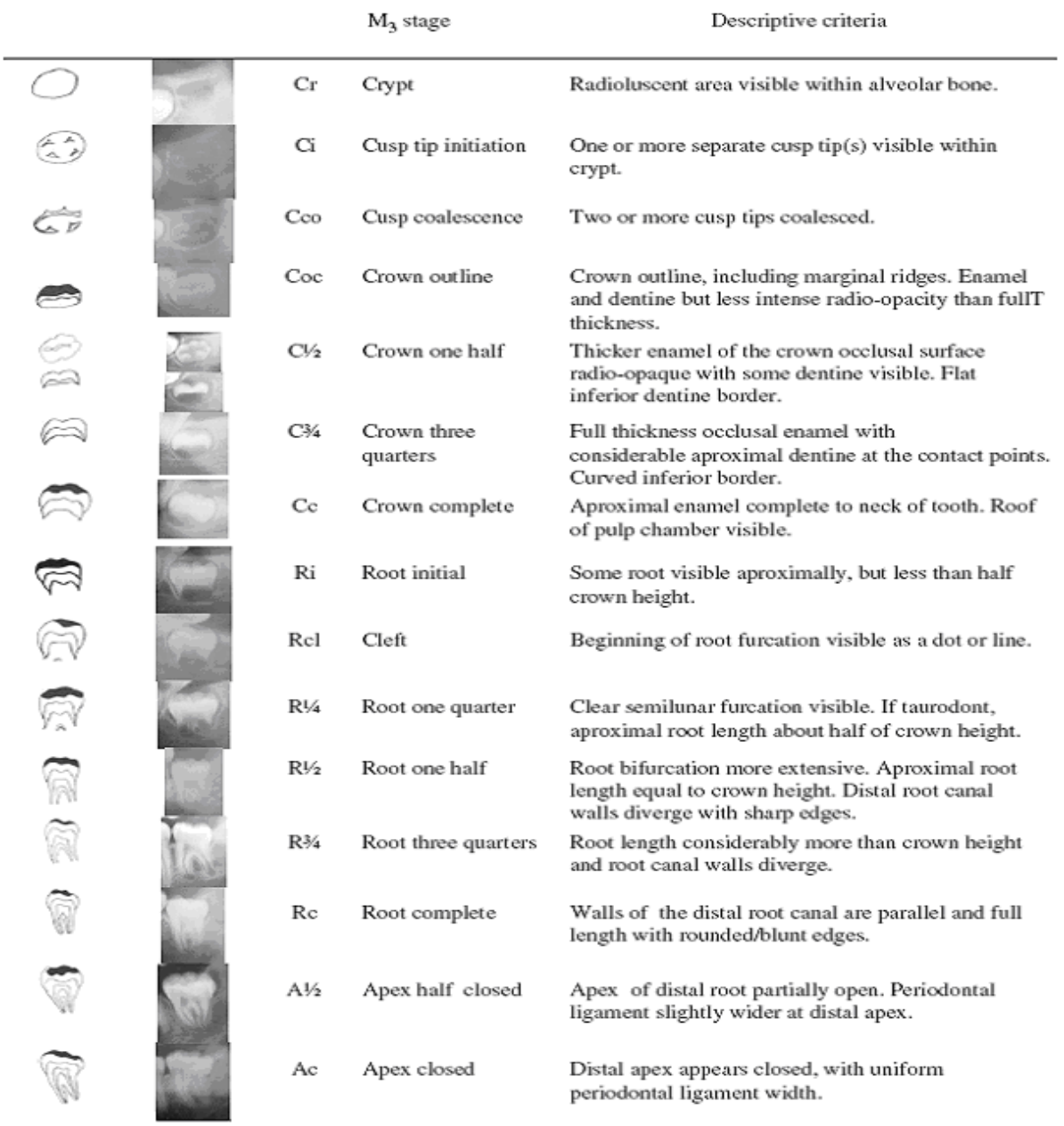
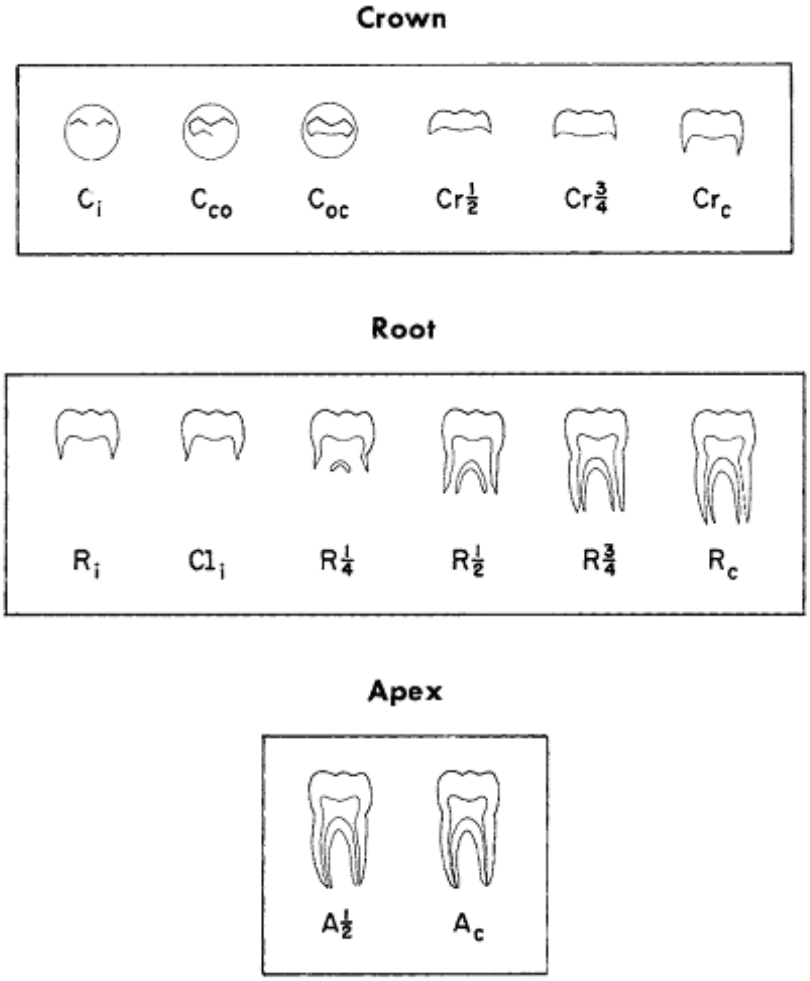


Fig. 1 – Stages of dental development described by Moorrees, Fanning et al. 1963 and rendered by Liversidge 2008. The stages start from crypt development (Cr) and end up with a stage representing when the apex of the distal root is closed (Ac). The total number of stages is fifteen.



Stage	Coded Symbol
Initial cusp formation	C_i
Coalescence of cusps	C_{co}
Cusp outline complete	C_{oc}
Crown ½ complete	$Cr_{1/2}$
Crown ¾ complete	$Cr_{3/4}$
Crown complete	Cr_c
Initial root formation	R_i
Initial cleft formation	Cl_i
Root length ¼	$R_{1/4}$
Root length ½	$R_{1/2}$
Root length ¾	$R_{3/4}$
Root length complete	R_C
Apex ½ closed	$A_{1/2}$
Apical closure complete	A_c

Fig. 2 –Stages of dental development modified from Moorrees, Fanning et al. 1963 by Haavikko 1970. It consists of 14 stages, starting with initial cusp formation (Ci) and ending with complete apex closure of root (Ac). Haavikko has not included the first stage, the crypt stage described by Liversidge.

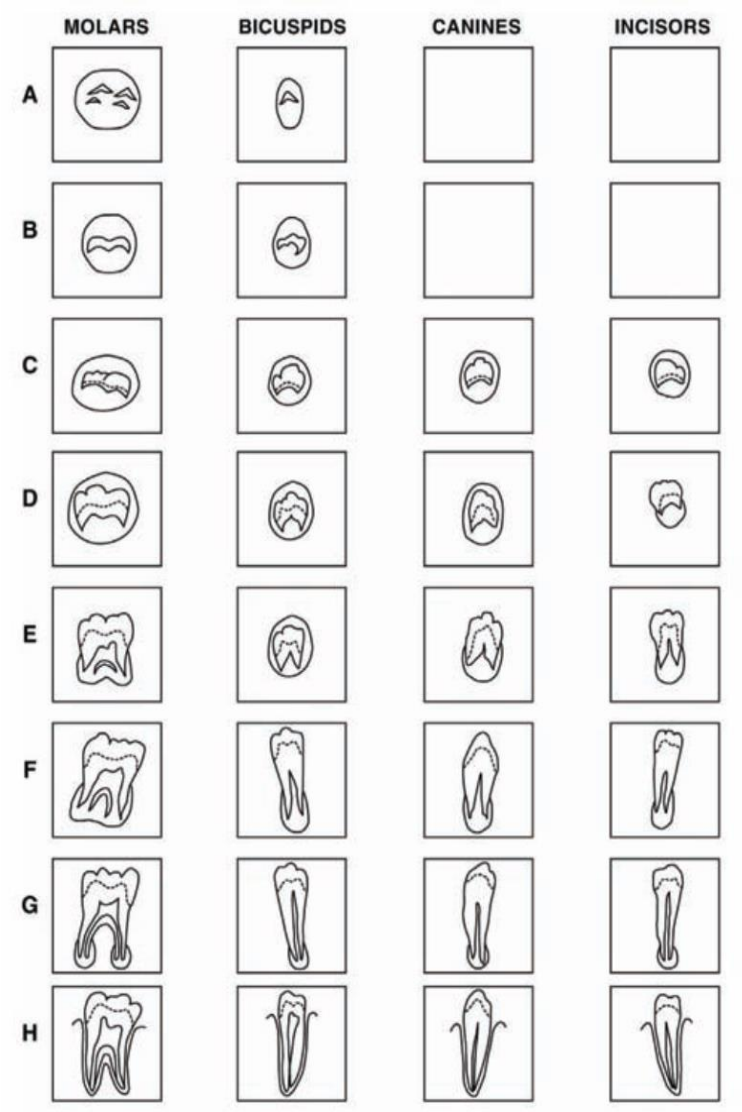


Fig.3 The eight dental developmental stages described by Demirijan et al.1973, rendered by Roberts et al. 2007.

Statistical analysis

We used t-test to assess the inter-observer differences. Our zero hypothesis was that it is not any significant difference between the inter-observer differences. The control and test results were not compared statistically.

Results:

Inter observer results;
Demirijan: 0,003268 and the zero hypothesis is rejected.
Liversidge; 0,000375 and the zero hypothesis is accepted.

The distribution of the materials with agenesis has been presented with the help of a pie chart (Fig 4). The majority of our patients had agenesis of two teeth. Only 5% had agenesis of three teeth and 40% had agenesis of one third molar

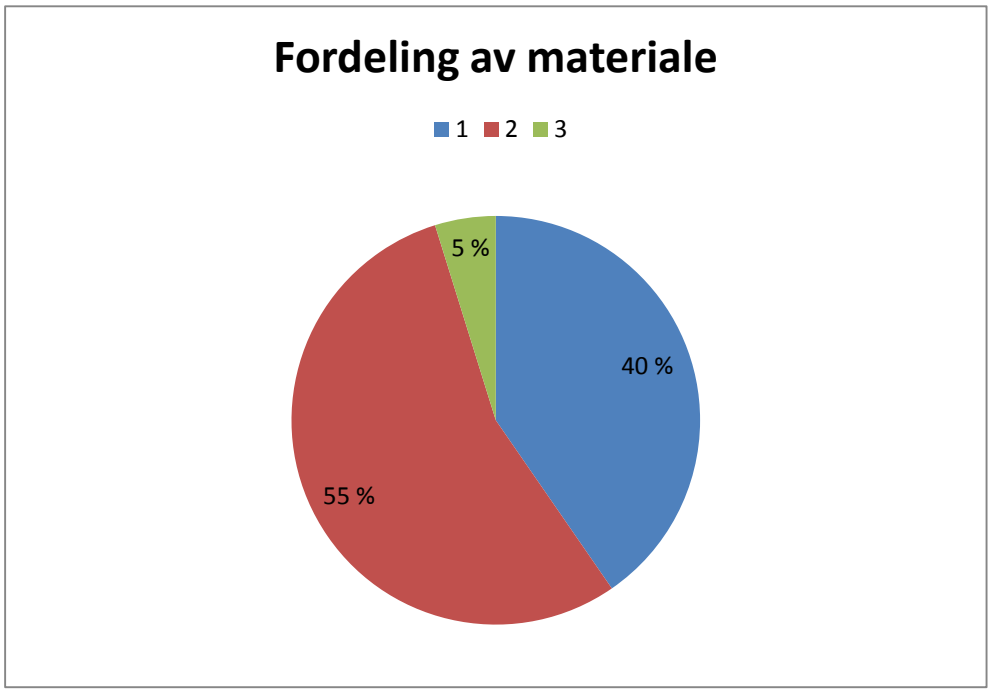


Fig 4. Distribution of the material representing agenesis. Blue: Agenesis of 1 third molar.Red: Agenesis of 2 third molar .Green: Agenesis 3 third molar teeth

From the diagrams, fig. 5 and 6 we can see that dentitions with agenesis are delayed in mineralization. Among the test group, the distribution was different compared to the control group. This finding was a fact when using scores according to both Demirijan et al and also Moorrees, Fanning et al

When using scoring systems modified by Demirijan, several of the teeth in the test group were categorized in grades C, D and E and a few were categorized as grade F, G and H. Grade C represents the earliest grade whilst H is the last stage in tooth development. Grades F, G and H represent an older age group than grades C, D and E. Grade C is not represented with an age in the table according to Mincer. This table represents crown-root formation and stage C represents a grade before the crown formation is complete. In the group with four third molar

present (the control group), the distribution was almost exclusively in the last three stages; F, G and H. Females with agenesis were more likely to have teeth in grade D, E, F and G. The dominating stages among men were F and G.

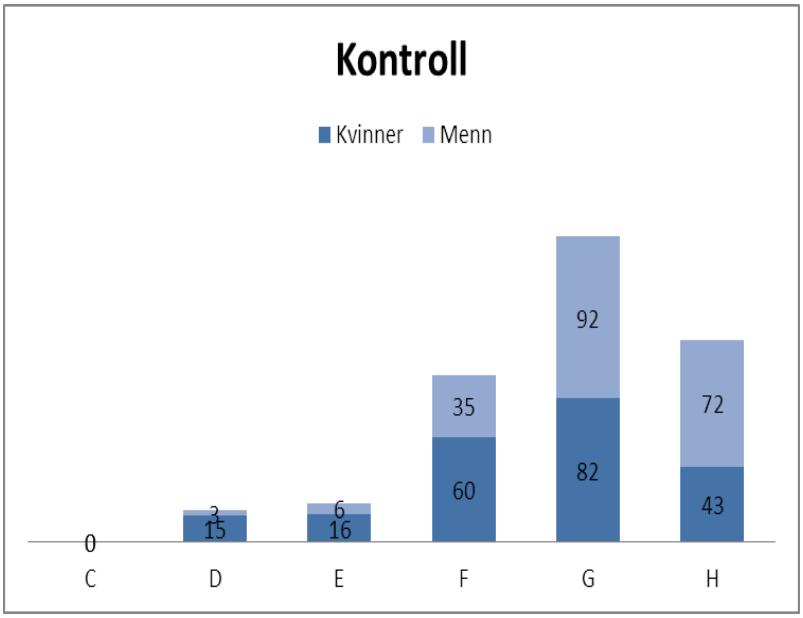


Fig 5. Control group - all third molar present. The total number categorized to be each part when using Demirijan, represented in each column. Kvinner: Females
Menn: Men

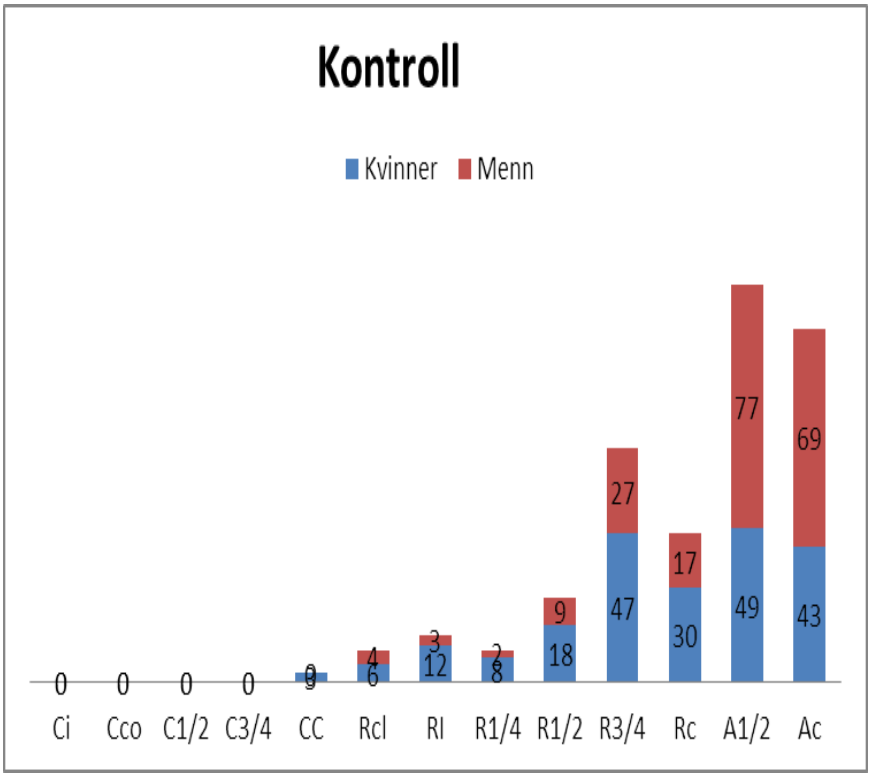


Fig 6. Mineralization stages of the rest of the teeth when having agenesis of 1-3 third molar. Number of scores according to Demirijan represented in each column.
Kvinner: Females Menn: Men

The comparisons between test and control, using scores according to Moorrees & Fanning et al. shown in Fig 7 and 8, indicate that most of the teeth in the agenesis group were categorized R1/2, R3/4 and Rc. These are different groups of root formation, where R1/2 is equal to half of the root formation completed. Rc indicates that the root length formation is complete.

The control group had several teeth categorized in A1/2 and Ac. A1/2 indicates that the apex is half closed while Ac indicates that the whole apex is closed (the last stage).

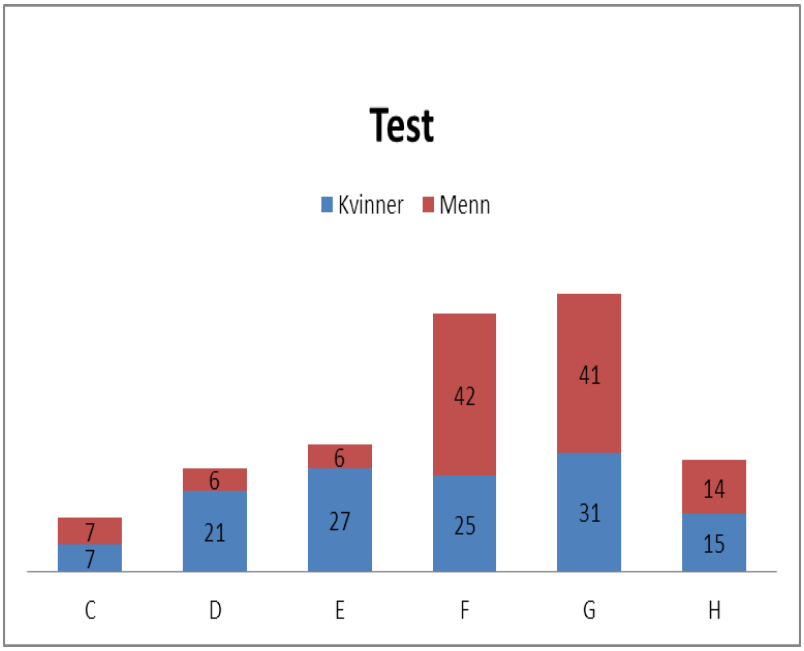


Fig 7. All third molar present. Number of scores according to Moorrees & Fanning et al. represented in each column. Kvinner: Females. Menn: Men

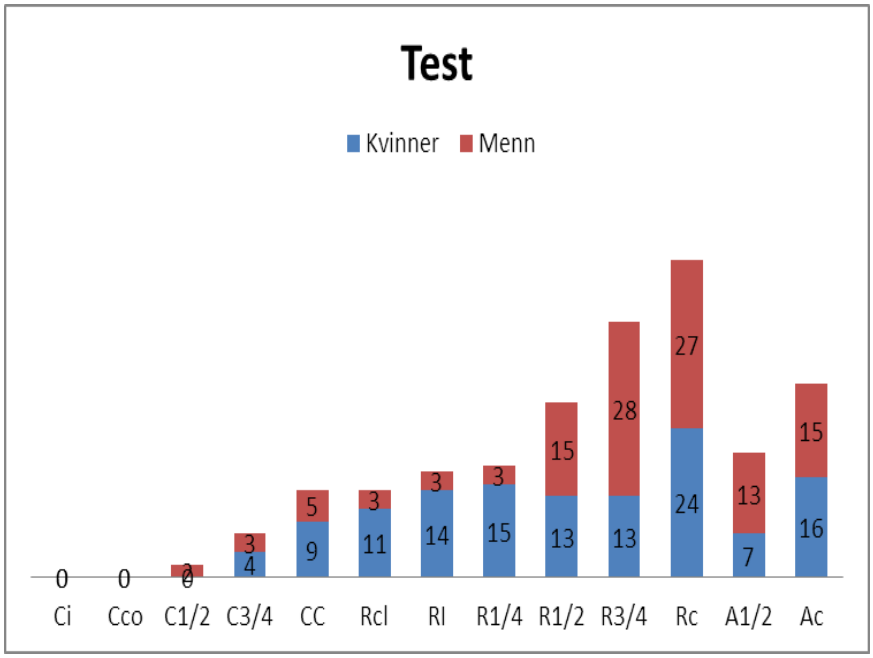


Fig 8. Mineralization stages of the rest of the teeth when having agenesis of 1-3 third molar. Number of scores according to Moorrees & Fanning et al. represented in each column. Kvinner: Females, Menn: Men

Discussion:

The variation in age estimation depends in whether the patients have agenesis or not. Since several of our test patients had teeth with low estimates both when using Mincer and Liversidge, indicates that those patients could have been wrongly estimated to be younger than the chronological age. There is a more even distribution in the test group, compared to the control group.

A1/2 and Ac equal to an age between 18-19, while Rc is estimated to be 18,1 years according to Liversidge [2008]. Below this grade, the patient is estimated to be younger than 18 years old. The majority of teeth in the test group were below Rc. The same result is also an outcome from tables made by Mincer. The majority teeth of the control group belongs to group H and G, indicating an age estimation of 18, 3- 20, 5 years old. On the contrary, the majority of test group is below grad G, indicating an age below 18.

When estimating age with the help of mineralization of the teeth, we have to know about the influencing factors. These factors may have an impact on the estimations and are therefore of importance when estimating age. Because we usually do not have the complete records of all the patients, it is difficult to tell if teeth are missing as a result of agenesis or are extracted. We can usually see if a tooth has been extracted with the help of x-rays, as we can detect the remains of lamina dura. However, this may present problems, especially in the upper jaw. The overlap of anatomical structures may complicate detection of lamina dura.

As globalization is growing day by day, the question of age stands even more strongly. As mentioned earlier, a lot of people coming from third world countries do not have identification papers showing their chronological age. In addition, another problem arises when these people neither have medical nor dental records to show if extractions have been made. What we do know, is that in most of the countries, regular dental check-up is uncommon. This again, can be used to imply that people, who lack third molar, do have agenesis.

According to Human Rights, it is important to be able to distinguish between adults or children i.e. individuals older than 18 years and those younger than this age. In this age group of young adults, the third molar is the only tooth that is still in a developmental stage. The maturation starts at the age of 7-9 years in the maxilla and 8-10 years in the mandible, and completes at the age of 20 years [Welbury et al 2005]. Studies show that the chance for males and females being older than 18 years is 96, 3% and 95, 1 %, if the individual has four fully developed third molar. [Mincer et

al 1993]

Children born in Norway get a birth certificate which is necessary for several purposes. In many third world countries birth registration is not compulsory and in some countries nonexistent. Many people living in these countries do not know how old they are. The Directorate of Immigration (UDI) in Norway requires birth certificate, passport or other form of documentation of age from refugees and asylum seekers. The majority of people seeking help as refugees or asylum seekers come from third world countries. Because they lack birth certificates, the age given may not be the correct chronological age. For different reasons the age given may be older or younger than the real age. From 2003, age estimation of asylum seeking children with disputed age has been performed in cooperation at Ullevål University Hospital, Unilabs, The Faculty of Dentistry and BarneSak in Oslo. This includes radiographs of the hand/wrist and teeth, and also incorporates an oral clinical examination. Very few conditions influence dental development, but agenesis may be one. [Sapoka and Demirjian 1971]

In the context of this, age estimation is of importance. It is important to make sure that everyone is treated in the same way according to the rules and regulation. In addition, age is of importance considering health related issues. Age is a factor that may decide medication and diagnosis.

The purpose of the proposed project was to study normal dental development in relation to age. It has been argued that normal development is not related to health issues. Congenitally missing third molar occur in approximately ¼ of the population and can almost be regarded as a normal variation.

Through this study, we wanted to know if the existing methods are relevant or if they need any kind of modifications. It has for a long time been known that agenesis do have impact on mineralization of the rest of third molar, but how much is unknown.

This study has some weak points, as the used methods to estimate age of our study groups, have been the same for everyone. We did not differentiate the test groups on the basis of their ethnicity. Staging tooth development according to both Moorees, Fanning et al (1963) and Demirjan et al (1973) have described using defined population. (Er det ok nå?, har endret til Moorees og lagt inn en ekstra setning som gjør avsnittet mer forståelig)

Liversidge [2008] compared the development of the mandibular third molar between two groups of children in England (one group consisting of white children and the second

consisting of children with Bangladeshi origin) and two groups of children in South Africa (one Indian/mixed race and the other Black-African children). She based her methods on 15 different dental developmental stages described by Moorrees et al [1963] that originally were described by Gleiser & Hunt [1955]. The development of third molar is graded according to the developmental stages shown in the diagram and picture of periapical dental radiograph (Fig 1). In this study by Liversidge patients with pathology or developmental disorders including agenesis of the left third molar or other teeth were excluded. In addition, she excluded third molars with unusual short roots, dysmorphology or in a position where the roots could not be visualized on radiographs.

Mincer et al. [1993] used the eight stages by Demirijan et al. to estimate age from third molar. Roberts et al and Mincer et al have used different statistical calculations. That consequently will obtain different age estimation. The latter method is widely used in other countries.

We did not distinguish between our patients based on their ethnicity. It could have been other results if we did distinguish. This finding indicates, as mentioned earlier, that the agenesis do have impact on the rest of third molar.

The material we ended up with was not what we wanted at the beginning. The aim was to get a representable material consisting of equal number of females and males. That was not possible; we ended up with more males than females. This may be a reflection of men having more agenesis then females, but it can also be a result of that The Faculty of Dentistry at that time had more males then females as patients. Another weak point was the distribution of agenesis; we did not have equal numbers of patients with one, two and three agenesis. The majority of our material had agenesis of two teeth. Having said that, what we can conclude after this study, is that agenesis of two teeth are far more frequent than agenesis of three teeth. The distribution of the material can therefore not be used to conclude that agenesis of three teeth results in a dental age which is younger then if the patient would have agenesis of only two teeth.

Comparing our results to previous studies show that our findings are similar to these. According to a study by Baba-Kawano 2002, late formation of tooth germs is one of the factors that lead to absence of lower third molar. This study only focused on the lower jaw, comparing the third molar to lower left premolars and second molars.

Another study made by Liversidge et al. 2010 shows that the methods we used, Demiirijan et al. and Morrees et al., to estimate age did not have any significant differences.

From our findings, it is recommended to do more research on this topic. There is a high risk in estimating the wrong age on people with agenesis, considering the fact that having agenesis delays the mineralization of the remaining third molars. Age estimation is a widely used method in human trafficking, child labor, youth sport and finally yet importantly asylum-seeking children, which in turn shows the importance of usage of more fail proof methods on people with agenesis. In the meantime, considerations during these age estimations on people with agenesis are important.

Conclusion:

Through our study, we have found that agenesis of third molars result in delayed mineralization of the remaining third molars . Our tables comparing the test and control groups using scores according to both Demiirijan et al (1973). and Morrees and Fanning et al.(1963)

A second finding in the study was that the difference between the tables according to Liversidge (2008) and Mincer (1993) is small, strengthening our hypothesis that there is no difference in using either table to estimate age.

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