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## Original Research Article

### **Age Estimation From Radiographic Evaluation of Various Developmental Stages of Maxillary Third Molars and its Associated Gender Variation.**

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Third Molar,  
Intra-oral peri-apical  
radio-graphs,  
Age,  
Development stages,  
Sex.

#### Abstract

**Background:** Forensic age assessment in living subjects has become increasingly important over the last few years in both civil and criminal cases, especially in the age group between 14 and 21 years. Two methods of age evaluation are available for juveniles in this age group: the radiologic examination of skeletal features and radiologic examination of the development of third molars. **Aims:** To evaluate the development of third molars in relation to chronological age and to assess the influence of gender on the development of third molar. **Materials and Methods:** Total of 66 outpatients were a part of this prospective study done between November 2013 to May 2015, for a period of 19 months. The development of the third molars in both the right and left quadrants of the maxillary region of the patients between age group of 15 to 25 years were assessed by taking intra-oral peri-apical radio-graphs. **Conclusion:** From this study one can be reasonably confident that the subject has not attained the age 18 years if the root development of third molar is between stage 1 to 4 and the developmental stage 7 indicates that the subject has attained the age 18 years.

#### 1. Introduction

Forensic age assessment in living subjects and dead persons has become increasingly important over the last few years concerning employment, marriage, and differentiating a juvenile from an adult in criminal cases, pregnant females in sexual

offence cases, especially for heinous crimes. Since tooth are the hardest structure in the body survives every disaster such as fire accidents, bomb blasts, plane crashes, mass disasters, etc.<sup>1</sup> Estimating age from teeth is reliable as they are naturally preserved long

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after all the tissues and even bones have disintegrated. Skeletal indicators, such as diaphysis–epiphysis fusion, hand–wrist examination, or changes in secondary sex characteristics, have their advantages and disadvantages. But especially during these years, they are more or less indecisive.<sup>2</sup>

Estimating age after about 14 years becomes difficult, since all the permanent teeth, except the third molar, would have completed their development leaving the third molars the only option for age estimation. It also offers a unique advantage over other teeth in that its development tends to continue over a longer period. At or after the age of 14, whether clinically visible or not, the status of the third molar helps in age estimation.<sup>3</sup> The study aims to determine the age based on radiological developmental changes in the root of third molars in subjects of age 15 to 25 years. The objectives of this study are to assess the influence of age and gender on the development of the third molar and to assess the difference in the development of 3rd molars between maxilla and mandible. This study was done as previous studies have not compared all the four molar teeth and there was a paucity of literature on similar studies worldwide.

## 2. Methods and materials:

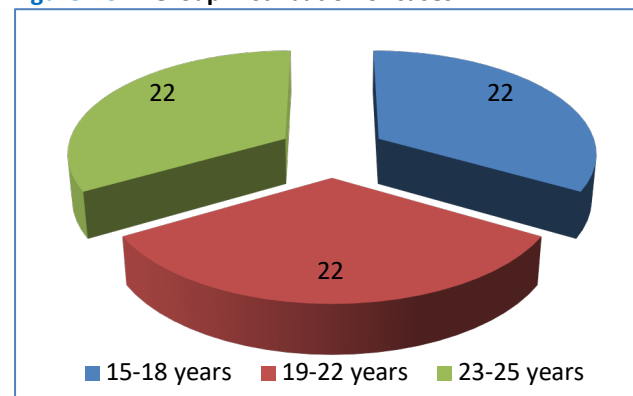
In this prospective study, 66 Outpatients, between the age group of 15 to 25 years of both sexes with validated age proof were selected from the Department of Oral Medicine and Radiology, M.S.Ramaiah Dental College and Hospital, Bangalore. Outpatients who had carries and fractures of the third molar were excluded from the study. Ethical clearance was obtained from the Institute Ethics committee of M.S.Ramaiah Medical College. Written informed consent was taken from each participant. The cost of the study was borne by the investigator. The tooth development of the third molar was assessed by taking intraoral periapical radiographs of all four third molars by four separate exposures from each of the subjects. The stages of root development were assessed by Leif Kullman et al method. Statistical analysis was done using Descriptive statistics, ANOVA test, post-hoc test using LSD, linear regression analysis, independent t-test. The data was analyzed using SPSS version 18.0.

## 3. Results:

A total of 264 (132) radiographs from 66 subjects were examined for the root development of third molars. The 66 subjects were divided into three

groups. Each group had 22 subjects (**Figure No 1**). Out of 66 cases, 34 cases were males and 32 cases were females. In the age group of 15 - 18 years, 12 cases were males and 10 cases were females. In the age group of 19-22 years, 11 cases were males and 11 cases were females. In the age group of 23 - 25 years, 11 cases were males and 11 cases were females (**Table No 1**).

**Figure No 1: Group Distribution of cases**



**Table No 1: Age and sex distribution of cases**

Age groups (in years)	No. of cases	Males (%)	Female (%)
15 - 18 years	22 (33.33%)	12 (18.18%)	10 (15.15%)
19 - 22 years	22 (33.33%)	11 (16.67%)	11 (16.67%)
23 - 25 years	22 (33.33%)	11 (16.67%)	11 (16.67%)
<b>Total</b>	<b>66 (100%)</b>	<b>34 (51.52%)</b>	<b>32 (48.8%)</b>

Leif Kullman et al method of root development (**Figure No 2**) was used to find the developmental stage of the analyzed cases and the age range and mean age of all the 7 stages of third molar development from the left and right maxillary quadrant of the participant cases were given (**Table No 2**). Mean age for the development of the third molar was found to be similar in all 7 stages when compared between both the left and right maxillary quadrants. There is no significant difference in age found between right and left maxillary areas (**Table No 3**). In the present study, there is no significant difference between the sexes up to stage  $\leq 5$ , but there is a significant difference between them once the stage is  $> 5$  i.e. root development of the third molar was earlier in males than females in both the left and right maxillary quadrants. But since the number of cases is less in stages 1 to 4, the comparison between males and females is statistically insignificant (**Table No 4**). The present study revealed that in both the left and right maxillary quadrants there is no statistically significant difference between stages 1 to 4. There is a significant

difference found between stages 1 to 4 and stages 5, 6, and 7 indicating that if the subject has root development of third molar reaching stage > 5 then one can be reasonably confident that the subject had attained 18 years of age. But if the subject has a developmental stage between 1 to 4, one can be reasonably confident that the subject had not attained the age of 18 (Table No 5 & 6).

Intra-class correlation and p-value between the dental parameter and chronological age were derived statistically and the value was 0.82 for right maxillary ('p' value < 0.001) and 0.84 for left maxillary ('p' value < 0.001). From this, it is evident that the

agreement between predicted age by dental parameter and chronological age has a good correlation as confirmed by the 'p' value. A Regression Formula to predict the age for each quadrant separately, based on the Leif Kullman et al staging of third molar teeth present, were calculated. The following regression equations were derived:

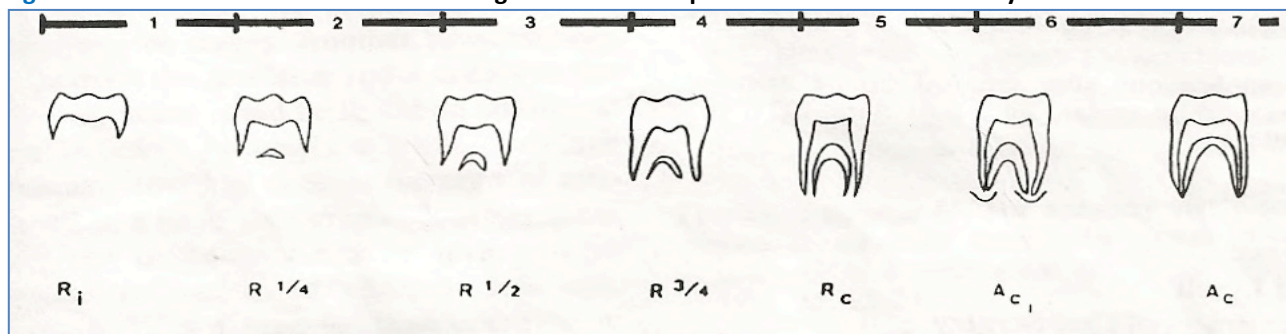
**Right maxillary**

$$Y \text{ (age in years)} = 1.131 \text{ (right maxillary stage)} + 14.82 \text{ (constant)}$$

**Left maxillary**

$$Y \text{ (age in years)} = 1.174 \text{ (left maxillary stage)} + 14.62 \text{ (constant)}$$

**Figure No 2: Classification of the different stages of root development of lower third molar by Leif Kullman et al method.**



**Table No 2: Age Range and Mean Ages of 7 stages in right and left maxillary quadrants**

Stages	Right Maxillary			Left Maxillary		
	No of Cases	Age Range	Mean Age	No of Cases	Age Range	Mean Age
1	10	15.08 - 17.92	16.37	9	15.08 - 17.67	16.20
2	2	17.58 - 17.75	17.67	3	16.50 - 17.75	17.28
3	7	16.50 - 18.17	17.20	7	16.83 - 18.17	17.25
4	2	17.83 - 18.25	18.04	2	17.92 - 18.25	18.09
5	10	17.92 - 22.58	20.39	10	17.92 - 22.42	20.26
6	26	17.83 - 24.92	21.91	27	17.83 - 24.92	21.97
7	9	20.83 - 24.83	22.49	8	20.83 - 24.83	22.51

**Table No 3: Mean ages with 95% confidence interval of all stages between right and left maxillary quadrants**

Stages	Right maxillary			Left maxillary		
	95% confidence interval for mean		Mean ± SD	95% confidence interval for mean		Mean ± SD
	Lower bound	Upper bound		Lower bound	Upper bound	
1	15.61	17.13	16.37±1.06	15.45	16.94	16.20±0.97
2	16.58	18.75	17.67±0.12	15.59	18.96	17.28±0.68
3	16.67	17.74	17.20±0.58	16.77	17.75	17.25±0.52
4	15.37	20.71	18.04±0.30	15.99	20.18	18.09±0.23
5	19.22	21.57	20.39±1.64	19.19	21.33	20.26±1.49
6	21.22	22.59	21.91±1.70	21.31	22.63	21.97±1.66
7	21.57	23.41	22.49±1.20	21.44	23.58	22.51±1.28
<b>Total</b>	<b>19.51</b>	<b>20.84</b>	<b>20.17±2.70</b>	<b>19.51</b>	<b>20.84</b>	<b>20.17±2.70</b>

**Table No 4: Gender difference of mean ages in Right and Left Maxillary Quadrant**

Stages	Right maxillary		Left maxillary	
	Males	Females	Males	Females

	No. of cases	Mean ± SD	No. of cases	Mean ± SD	No. of cases	Mean ± SD	No. of cases	Mean ± SD
1	4	16.21 ± 1.0	6	16.47 ± 1.19	4	16.21 ± 1.0	5	16.18 ± 1.06
2	2	17.67 ± 0.12	0	-	3	17.27 ± 0.68	0	-
3	2	16.75 ± 0.35	5	17.38 ± 0.57	2	16.91 ± 0.12	5	17.38 ± 0.57
4	1	17.83	1	18.25	0	-	2	18.09 ± 0.23
5	6	20.21 ± 2.03	4	20.67 ± 1.03	6	19.99 ± 1.78	4	20.67 ± 1.03
6	14	21.58 ± 2.0	12	22.29 ± 1.27	14	21.67 ± 1.99	13	22.29 ± 1.22
7	5	22.12 ± 1.11	4	22.96 ± 1.29	5	22.12 ± 1.11	3	23.17 ± 1.50

**Table No 5: Comparison of mean age between different stages of right maxillary quadrants**

Stages	1	2	3	4	5	6	7
1	-	0.245	0.240	0.136	<0.001	<0.001	<0.001
2	-	-	0.688	0.794	0.017	<0.001	<0.001
3	-	-	-	0.467	<0.001	<0.001	<0.001
4	-	-	-	-	0.006	<0.001	<0.001
5	-	-	-	-	-	0.006	0.002
6	-	-	-	-	-	-	0.295
7	-	-	-	-	-	-	-

**Table No 6: Comparison of mean age between different stages of left maxillary quadrants**

Stages	1	2	3	4	5	6	7
1	-	0.248	0.092	0.087	<0.001	<0.001	<0.001
2	-	-	0.904	0.526	0.002	<0.001	<0.001
3	-	-	-	0.537	<0.001	<0.001	<0.001
4	-	-	-	-	0.048	<0.001	<0.001
5	-	-	-	-	-	0.001	0.001
6	-	-	-	-	-	-	0.340
7	-	-	-	-	-	-	-

#### 4. Discussion:

The third molar is also known as wisdom tooth if fully erupted, indicates that an individual is above 17 years of age. In some persons due to inadequate jaw space, the third molar never erupts into the oral cavity, particularly the mandibular third molars. From 14 to 20 years, dental age estimation is based upon the stages of development of the third molar.<sup>4</sup>

Out of 66 cases, 34 cases were males and 32 cases were females. In the age group of 15-18 years, 12 cases were males and 10 cases were females. In the age group of 19-22 years, 11 cases were males and 11 cases were females. In the age group of 23-25 years, 11 cases were males and 11 cases were females. A similar study was conducted by Vrinda et al consisting of 85 subjects in the age group of 15 to 25 years. Out of these 41 were boys and 44 were girls.<sup>5</sup> Naik et al study was carried out on 100 digital orthopantomograms of patients in the age group of 7 to 24 years. Out of 100 patients, 53 were males and 47 were females.<sup>6</sup>

Tables 2 and 3 show the mean ages with a standard deviation of all seven stages in both the right and left maxillary quadrants. The present study showed that mineralisation of the third molar's root was found to start at the age of 15.1 years and the root was fully formed at about 21-23 years. Kullman et al study showed that mineralisation of the third molar's root was found to start at the age of 15 years and the root was fully formed at about 20 years.<sup>7</sup> Vrinda et al study showed that the root calcification started at 15.1 years and was completed at 19.3 to 20 years.<sup>5</sup> In a study by Darji et al, if a subject presents with a developmental stage A to D based on Demirjian et al method there is less likelihood that subject is 18 years old. On the other hand, if the subject presents with the developmental stage of H (i.e. complete closure of root apex), there are more chances that the subject has crossed the 18 years of age.<sup>8</sup> In Panchbhai AS study, the comparison of the level of development of the third molar by Nolla staging in-between right and left maxillary quadrants was found to be insignificant except for the upper arch in females.<sup>9</sup>

Kanmani et al, Sisman et al and Attar and Al-Taei's studies showed that the third molar genesis attained by the Demirjian formation stages was earlier in males than in females.<sup>10,2,11</sup> In a study by Mesotten et al, completion of third molar formation occurred earlier in males than females.<sup>12</sup> In a study by Kasper et al, all stages of development for both jaws showed the mean ages for males to be lesser than female mean ages.<sup>13</sup> Barka et al study showed that no significant difference was found between the third molars 18 and 28 and 38 and 48 in males or females.<sup>14</sup>

### 5. Conclusion:

The present study was adopted for the reason that there is a paucity of literature on a study on root development of third molars based on Leif kullman et al method in India as well as the rest of the world. If the root development of the third molar was found to be between stages 1 to 5, then the subject has not attained the age of 18. If the stage of root development was found to be 7 (i.e. Root apices closed), one can be reasonably confident that the subject has attained the age of 18 years. There is good agreement between the dental age and chronological age. Root development of third molars was earlier in males than females. The present study will be useful to estimate the age in pregnant females by third molar development where other joint x-rays would not be possible concerning the exposure. The present study throws light on determining the age of 18 years in an individual who is medico-legally significant.

**Ethical Clearance:** IEC approval is taken from the Institutional Ethical committee.

**Contributor ship of Author:** All authors equally contributed.

**Conflict of interest:** None to declare.

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