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## Case Report

# Human teeth as a reliable age marker: A study on migrant labour population

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### ABSTRACT

Age is one among the factors which is supposed to be identified in establishing identity of an unknown or deceased person. It is found to be more reliable and accurate to determine the age of a person. The determination of age can be achieved from various physical markers present in body, this includes teeth, bones, and skull. There is certain age where the long bones tend to complete their growth, the growth of skull is well marked by the time of order of their suture closures. A well-developed cranial bone depicts that it is intersected with a suture. Besides the bone and skull another reliable physical marker is the human teeth, teeth is considered to be the hardest tissue in humans which is not affected by the factors such as heat, temperature, moisture etc. it is an effective identifier in cases of mass disaster where it is practically impossible to determine the identity of the person through the bones available from the crime site.

Teeth is a very important factor to determine the age in disputed cases. Since the age can be estimated even from skeletal remains, teeth are preferred for estimation in certain cases as it is considered to be one among the hardest tissues of the human body. Teeth has got a very unique feature as it cannot be destroyed by heat or any thermal factors or other environmental factors. This property of the teeth has to be effectively utilized for age estimation. The following study was conducted on migrant workers working on a peeling company, the purpose behind the study is to determine whether all the workers have 18 years of age and to ensure that no or none of them are working below the age of 18. There are certain cases reporting that some of these workers have found committing impersonating forgery claiming to be above 18 years of age. The study is specifically to find the age of workers by examining the teeth and also to find if any forgery is done or not. This study was also done to check whether labor laws has been violated or not in accordance with the Constitution of India, no child below the age fourteen years of age shall be employed to work in any factory or mine or engaged in any other hazardous employment, therefore employment of a child under the age of 14 years is punishable by law (child labor prohibition and regulation act of 2012). The need of the study arises from this very fact that the proof of age is not an authenticated document. With repeated reports of forgery regarding the proof of age, submitting ration card as proof of age. And in the wake of current scenarios to ensure that no child is exploited in any kind of ways. The study was done on migrant labor population working in a factory and the estimation is carried out using the Demirjian method<sup>1</sup> along with Acharya's<sup>2</sup> India specific value and the probable age of the respondents are calculated.

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## 1. Introduction

Human beings have teeth with rich and unique anatomic characteristics. The normal tooth form is extremely varied with every individual and is very difficult to reproduce. The

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normal anatomy of teeth assures efficiency of mastication. Mastication is the primary function which includes cutting, shearing and chewing. Deglutition and swallowing is done with the help of tooth.

Humans are diphyodonts, a dentition in which the species have two sets of teeth, one set called deciduous being shed and replaced by a permanent set of teeth which are functional throughout the life. Examples cats, dogs and humans.

### 1.1. Primary or milk teeth

There are 20 deciduous teeth, ten in mandible and maxilla respectively and are grouped into three classes.

#### 1. Incisors

They are the first primary teeth to erupt and usually between 6-9 months. The last usually erupted by 24 months.

1. Canines
2. Molars

Commonly observed features:

1. Both the arches are half round in shape.
2. Slight overjet and overbite.
3. Vertical inclinations of incisors.
4. Little or no crowding.
5. Different maxillomandibular molar relation.

It is generally observed that primary spacing occurs around 70% in maxilla and 63% in mandible. Baume in 1950, divided the deciduous dentition into spaced and non-spaced dentition.

### 1.2. Temporary teeth

There are 32 permanent teeth out of which sixteen are maxillary and 16 are mandibular that are grouped into 4 classes:

- \* Incisors
- \* Canines
- \* Premolars
- \* Molars

The first secondary tooth to erupt in the oral cavity is the first molar and usually erupts around 6 years of age and the last to erupt is the 3<sup>rd</sup> molar around 21 years of age. All the other teeth are present by 14 years of age.

### 1.3. Dental formula

It is a way of designating or indicating the number or arrangement of teeth for a given species but used mainly for mammalian teeth. The teeth of upper jaw are listed over the lower jaw. The dental formula is described only on one side of jaw which represents the teeth on one side of the face

of both jaws and is done so because the jaw is bilaterally symmetrical. The incisors are indicated first followed by canine, premolars and molars.

**Table 1:**

<b>Upper</b>	ICPM	3143
<b>Lower</b>	ICPM	3143

### 1.4. The age estimation

A dentist named Edwin Saunders is considered to be the initial person to carry out the dental implications in assessing the age of an individual stating "teeth a test to age". further with the advancements of various technologies and using of scientific methodologies to substantiate the findings further more methods were developed.

## 2. Methods of age estimation

The methods of age estimation can be categorized as

1. Morphological methods
2. Radiological

Gustafson<sup>3</sup> in 1894 prescribed a method which uses 6 criteria for estimation of age and these are prescribed as follows:

1. Attrition of teeth
2. Secondary dentine deposition
3. Peridontosis
4. Cementum deposition
5. Root resorption
6. Dentinal transparency

This is based on the regressive changes which ranges from 0-3 and the other subsequent grade points are assigned.

Radiological methods are used as it can be studied on both living and the death. The radiological methods use the following factors such as the:

1. Tooth eruption
2. Apices of tooth
3. Ratio of pulp to tooth

### 2.1. DEMIRJIAN method

This study basically uses the DEMIRJIAN method<sup>1</sup> which was introduced in 1970s which uses a 8 tooth recognition marking an individual score for each tooth and these scores are summated to a total score. Currently the age estimation for Indian samples is calculated by combining the DEMIRJIAN and Acharyas<sup>2</sup> to solve the age dispute with minimum discrepancy using the DEMIRJIAN eight grade classification information may determine if at all a person is 18 years of age. The eight-grade classification of

tooth development demonstrate one method of determining according to developmental stages of the third molar.

DEMIRJIAN designed a method of age prediction, which employs seven mandibular teeth that is present to the left side. The method has been widely used in age estimation but nonetheless has shown certain type of variation as the population differs including Indians. For optimal precision of age estimate the methods adaptation to the local population is recommended.

A drawback of the original method was that it excluded the third molar owing to its tendency to be congenitally missing and also because of wide variation in its development. Nevertheless, this tooth is one of the few predictors available for the assessment of age in the 16–23 year age-group and, hence, was assessed by others using DEMIRJIAN's criteria. With an intent to broaden the applicability of the original method up to the age of 18 years, CHAILLET and DEMIRJIAN incorporated the third molar in an assessment of age in French children.<sup>4</sup>

India-specific formulas were derived using regression analysis, wherein the total maturity score obtained for each individual (based on maturity scores in was entered as the independent variable and the corresponding age (in completed years) as the dependent variable in the SPSS 10.0 statistical program.

In India, legal necessities for age estimation in this age-group include questions regarding criminal liability of an individual (a child less than 12 years is not, under certain circumstances), employability (work by children less than 14 years constitutes child labor), status of majority (18 years), and eligibility for marriage (18 years is the legally permissible age for females and 21 years for males).

The recently used method is the DEMIRJIAN's method that is based on 8 stages of calcification of the teeth that incorporates the crown and root calcification to the crest closure for the 7 permanent mandibular left teeth. A point is given to every stage, and the summation of the points gives an estimation of the persons dental maturity or age. The total maturity score may then be converted into a dental age by using tables and percentiles curves particular points, standard to 100 that are specific for girls and boys for each stage and left mandibular teeth \* DEMERJIAN 8-teeth method and polynomial functions.

To obtain age as a function of the maturity score, we calculated a cubic function between the real age and the maturity score for the eight mandibular teeth ( $Y = aX^3 + bX^2 + c(X) + d$ , with Y as age and X as maturity score). We obtain an age prediction with 95, 97, and 99% CI. Moreover, this analysis is easy to perform to calculate new maturity curves if teeth are missing or for another population.

Girls: Age =  $(6, 15E - 05 * \text{Score}^3) - (0, 0106 * \text{Score}^2) + (0, 6997 * \text{Score}) - 9, 3178 \pm 2, 01$  years (95% CI),  $\pm 2, 33$  years (97% CI),  $\pm 2, 65$  years (99% CI)  $R^2 = 0, 91$

Boys: Age =  $(5, 50E - 05 * \text{Score}^3) - (0, 0095 * \text{Score}^2) + (0, 6479 * \text{Score}) - 8, 4583 \pm 1, 73$  years (95% CI),  $\pm 1, 97$  years (97% CI),  $\pm 2, 28$  years (99% CI)  $R^2 = 0, 93$  the confidence interval is homogenous for all the age groups. The reliability of the polynomial method is higher than the percentiles score's one but its accuracy is lower. This method is appropriate for the study of age prediction if the aim is the reliability (for example, in forensic analysis).

### 2.1.1. Error in age estimates

There are two main sources of error in age estimates:

1. Variability in aging process between individuals/populations.
2. Methodology bias.

### 2.2. Advancements in teeth age estimation

Study of tooth cementum additions requires thin sectioning of a tooth root and viewing it under a light microscope. Age estimation is usually accomplished by viewing the root in cross section and adding the total number of cementum rings to estimated age at which the tooth erupted. There are certain software's that uses fourier analysis and algorithms as a means of image analysis. The program scans the image and counts gray scale peaks within specific areas. Age can be assessed by looking a number of aging techniques simultaneously.

## 3. Methodology

The following study is conducted at a company and the estimation of age of its employees is conducted using the method of DEMIRJIAN method. The reason why the DEMIRJIAN method is used since it offers more accuracy and precision and has less error rates as compared to the various other methods. It is best method for analysis for the Indian population. Teeth resist postmortem change and destruction on account of their inorganic content. Consequently, the dentition has been routinely applied in forensic investigations around the world. The variable tooth anatomy, in terms of size and surface morphology has applications in reconstructive identification of skeletal remains. While tooth measurements can be adjunct in assessment, morphological features have relevance in identifying the population. However further research is needed to establish tooth size and morphology databases and validate the methods for forensic investigation.

1. The migrant labour population of peeling company was selected with female workers of age group between 16 to 22 years of around 30 workers. Dental OPG of each sample was recorded and marked individually.
2. Evaluation of dental maturity was calculated using the demerjian 8 teeth method. For estimation of dental

Table 2:

Girls	31	32	33	34	35	36	37	38
0								6.40
1							2.57	7.74
2					2.43			8.92
3				2.56	3.43		2.65	9.31
4			2.55	3.54	3.83		4.10	10.22
5	2.58	2.65	3.15	5.09	5.75	2.58	6.51	11.04
6	3.10	4.54	5.40	6.31	6.81	3.25	8.00	12.65
7	5.02	5.40	7.19	8.09	8.70	4.25	9.13	13.77
8	6.66	7.02	9.22	9.82	10.80	6.88	11.00	14.45
9	10.61	10.89	11.99	12.29	12.79	10.94	13.84	16.65
Boys	31	32	33	34	35	36	37	38
0							1.70	6.19
1					1.69		2.98	7.64
2				1.70	2.27		3.41	8.28
3			1.70	1.98	3.41		4.74	8.86
4			2.67	3.52	3.41		4.88	9.89
5	2.31	2.55	4.34	5.19	5.59	2.13	6.69	11.17
6	4.35	4.71	6.14	6.47	6.96	3.73	7.89	12.25
7	5.16	5.75	7.59	8.18	8.68	4.94	9.08	13.66
8	6.56	6.97	9.52	9.84	10.64	7.00	11.13	14.07
9	10.68	10.91	12.56	12.57	13.11	11.22	13.63	15.32

age, all the lower left mandibular teeth were evaluated. Examiner assigned each tooth with the corresponding Demirjian stage and later each tooth was allocated with a score depending on that stage. Sum of all the 8 teeth gave the maturity score (S). Then the score was substituted into the regression formulae given by Dr Acharya to estimate the age.

- Female age =  $23.7288 - (0.0088 * s^2) - (0.000085 * s^3)$ .

All the teeth are rated on a scale of A to H and the rating is done by following the criteria s and comparing the tooth with diagrams and x-ray pictures.

### 3.1. Dental formation stages

If there is no sign of calcification the rating 0 is given. The crypt formation is not taken into consideration.

### 3.2. Stage description

- In both UNI-radicular and multi-radicular teeth, a beginning of calcification is seen at the superior level of crypt in the form of an inverted cone. There is no fusion of these calcified points.
- Fusion of all calcified points forms one or several cusps which unite to give a regularly outlined occlusal surface.
- Enamel formation is complete at the occlusal surface. Its extension and convergence towards the cervical region is seen.

The beginning of a dentinal deposit is seen.

The outline of the pulp chamber has a curved shape at the occlusal border.

- The crown formation is completed down to the CEMENTO-enamel junction.

The superior border of the pulp chamber in the UNI radicular teeth has a definite curved form being concave towards the cervical region. The projection of the pulp horns if present gives an umbrella top. In molars the pulp chamber has a trapezoidal form.

Beginning of root formation is seen in the form of a spicule.

- UNI radicular teeth.

The walls of the pulp chamber now form straight lines, whose continuity is broken by presence of pulp horn, which is larger than in previous stage.

The root length is less than crown length.

### 3.3. Molars

Initial formation of the radicular bifurcation is seen in the form of either a calcified point or semi lunar shape.

The root length is still less than the crown height.

### 3.4. Study procedure

- Data was collected using a structure proforma which considered demographic details such as age and gender.
- The statistical analysis was carried out using regression analysis.

### 3.5. Relevance of study

1. A state with a migrant labour population of about 5 to 5.5 million in 2020 which is referred as silent revolution of great migration the real relevance of the study arises :
2. Whether these people qualify the legal age of working?
3. Whether they have adequate age proof to substantiate the same?
4. Most of these people come without relevant documents and keeping in mind the hazardous working conditions, and chances of human rights violations, exploitation of all kinds and even when these people commit crimes.

### 4. Case Study

**Table 3:** The X-ray image revealed 32 permanent number of teeth

Tooth (No*)	Developmental Stage	Maturity Score
Lower left 1 <sup>st</sup> incisor (31)	9	10.61
Lower left 2 <sup>nd</sup> incisor (32)	9	10.89
Lower left canine (33)	9	11.99
Lower left 1 <sup>st</sup> premolar	9	12.29
Lower left 2 <sup>nd</sup> premolar (35)	9	12.79
Lower left 1 <sup>st</sup> molar (36)	9	10.94
Lower left 2 <sup>nd</sup> molar (37)	9	13.84
Lower left 3 <sup>rd</sup> molar	5	11.04
Total	68	94.39

\*Federation Dentaire International (FDI) Tooth Numbering System.

#### 4.1. Most likely age of

1. Since tooth development is considered to vary across populations, a customised age estimation formula was derived using a statistical procedure called regression analysis. This method is applicable to Indian children, adolescents and young adults. This was formulated and published by Acharya (2011a) and the wisdom tooth was also included. The formula is a third degree polynomial function and assessed the age ranges from 7 to 25 years. Therefore the most likely biological age of MS X is 16.8 years and corresponds to a person in range of 15.2 TO 18.4 years
2. Probability of MS X being  $\leq$  18 years of age.

3. A statical procedure called binary logistic regression analysis recommended by the research paper of Acharya 2011b demarcated the subject into (1) less than 18 years of age or (2) > 18 years of age. The developmental stages of each tooth individually and their development stage provided the probability rates for the subject being < or > 18 years of age. This probability also thereby indicates 94.39% a very high likelihood of MS X being under the age of 18 years.

### 5. Conclusion

1. Use of human teeth as a reliable age marker has been restricted to only anthropological cases but it has an endless possibility in other forensic aspects too. The outcome of this study was such that migrant labors work without required formal papers or even without a proof of age lights us to the existing labor laws of our country. According to the UNICEF report 12% of children in India engage in child labor and some of them being hazardous, this is a proof that still there are unaccountable number of children denied the basic rights as a citizen. Alarming concern regarding the increased crime rate among the migrant labourers.
2. The identification records are either false.
3. Or by incompetent authorities such as “sarpanch”/ village head putting a question upon their nationality, particularly migrant labours with facial dissimilarity such as Nepalis or north eastern population.
4. Also for curbing cross border terrorism as a proactive forensic tool.

### 6. Recommendations

After the completion of the study it was found the need of using the dental records for the estimation of age along with the current existing personal identification criteria. Teeth is the unique feature just like the fingerprints but the fingerprints show certain deformations and sometimes becomes difficult for comparison but teeth are unaffected by such deformations hence is best for estimation. There by recommends for the use of dental records along with the personal identification systems existing. There is no single person in their lifetime without undergoing a dental treatment, and teeth being a unique feature just as the fingerprints has to effectively exploited. Such an effort could possibly help in age estimation procedure, as every smile is unique, and can effectively be analyzed.

### 7. Source of Funding

None.

### 8. Conflict of Interest

The author declares no conflict of interest.

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