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Reconstructive Post- Mortem Dental Profiling: A Comprehensive Review (Part I- Ethnicity And Sex Determination)

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Abstract:

Forensic odontologist play an important role in identification of the victims of crime and disaster with the help of dental records which aids in investigation. Forensic dental identification is of two types. Firstly comparative dental identification which is carried out if both ante- mortem and post- mortem dental records are available. Secondly if ante mortem records are not available for identification, a post-mortem dental profiling is carried out by the forensic odontologist by analysing the parameters like ethnicity, age, sex, socioeconomic status etc to restrict the hunt for ante- mortem dental records. This process is called post- mortem dental profiling. Having done this, still if not able to establish the identity of the victim, a skeletal analysis team can be formed by forensic anthropologist, forensic odontologist and reconstructive practitioner for further search. Therefore on the basis of skull of the deceased and with the help of forensic odontologist the reconstructive practitioner can give lifetime resemblance of the skull. This process of recovering, regenerating and re- establishing of needed information for the reconstruction of life time resemblance of skeletal remains by post mortem dental profiling is called reconstructive post mortem dental profiling. This reconstructive post mortem dental profiling gives unique dental features of each person which has more practical values for the identification of the unknown persons. This helps the forensic odontologist to review their jobs with wider prospective and to document the dental profiles in the absence of ante- mortem records.

Keywords: *Forensic Odontologist, Ante- Mortem, Post Mortem, Dental Profiling, Reconstruction, Ethnicity, Sex Determination*

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Introduction

Forensic odontology is a branch of dentistry, medicine as well as forensic science playing an important role in human identification, age estimation, bitemark analysis, child abuse and various other civil and criminal cases possessing dental evidence. Forensic odontology is therefore defined by Federation Dentaire Internationale (FDI) as "that branch of dentistry which, in the interest of justice, deals with proper handling and examination of dental evidence and with the proper evaluation and presentation of dental findings". The primary function of forensic odontologist is identification of unknown remains using dental features. Comparitive dental identification and post-mortem dental profiling are the two types of human identification in forensic odontology. Comparitive identification is done when both AM and PM dental records are available. If AM dental records are not available, a forensic odontologist carries out a process of establishing identity by analysing the parameters like ethnicity, sex, age, economic status, personal habits, occupation, dietry habits, systemic and dental conditions from the dental component of the unknown remains. This process is called Post- mortem Dental Profiling. It is called Reconstruction because it involves in meticulous adjoining of different dental portion to form a single unit starting from simple piece of dental recovery to life time regeneration.

Purpose of Dental Profiling

The precise identification of the unknown remains can be done with the help of AM dental records. PM dental profiling plays an important role in reconstructing the identity when these records are not available, skeletal remains in an abandoned place and sometimes with inconclusive DNA results. Ethnicity, age estimation and sex determination are the basic triad of PM dental profiling (Figure No.1). The identification of persons stretched out for a long time gives lawfulness and restfulness of family members, relatives and friends of the deceased **(Pretty and Sweet, 2001).**

Figure No. 1: Triad of PM Dental Profiling

The information obtained from this process acts as a nucleus in the search for AM dental records. The execution of dental profiling can be done by visual examination of oral cavity (invasive manual method), radiographs, computer softwares like Dentascan, virtopsy and virdentopsy by Emilio Nuzzolese (non-invasive method).

Identifying Ethnicity from the Teeth

The phenomenon of identifying ethnicity from the teeth involves the anthropological schooling metric and non- metric dental traits from the tooth anatomy. The metric traits are based on odontometric measurements like mesio- distal, bucco- lingual, crown height and cervical measurements where as non- metric dental traits are concerned with morphological features of the teeth.

The forensic point related to dental metrics are based on absolute size of teeth and relative size of teeth. This is given by dental indices which are based on population differences of tooth metrics either in "size differences" or "shape differences". The absolute size of teeth was described by Flower as three dental classes by using Dental Index Formula namely, Microdonts (dental index< 42, European White groups), Mesodonts (dental index 42- 44, Asians) and Megadonts (dental index> 44, Australian aborginals and American Blacks).

Dental Index = Dental length/ Basion - Nasal length X 100

Dental length - Distance between mesial surface of I PM to distal surface of 3rd Molar.

Basion- Nasal length- Distance between Basion to Nasion

The research in relative size on teeth showed Australians with larger second molar, Asians with larger anterior teeth and another research showed whites have second lateral incisor much smaller than central incisors.

Ethnicity from Non- Metric Dental Traits

Non- metric dental traits are certain morphological features of teeth which are inheritable and shows variation in expression both within and between the populations. The significance of these traits are they occur in a pattern in a particular population with a particular frequency. The teeth form is considered to be highly heritable trait with threshold expression resulting from equal and additive genetic effects that are evolutionarily conservative and selectively neutral **(Rathman and Centeno, 2020)**. The specific concerns like sexual dimorpism, inter- trait association, counting methods **(Turner *et al*., 1991)**, grade shift, situations like teeth in life, cast and

skeleton, outer enamel surface, enamel dentin junction and observer errors speaks for preservability and observability of non- metric dental traits **(Scott and Irish, 2017)**. The genetic theories behind non- metric dental traits like field theory **(Srivastav *et al.*, 2018)**, clonal theory, gene frequency variation **(Scott, 1992; Shinoda and Nishimoto, 1998)**, homeobox genes and neutral genome variation address the variability and heritability of these traits. The leading edge of non-metric traits over cranial elements accounts for relative accuracy of these traits **(Rathman and Centeno, 2020).**

Non- metric dental traits are scored using Arizona State University Dental Anthropological System (ASUDAS) which was given by Scott and Turner. It comprises of reference set of dental casts illustrating expression levels for various traits along with specific instruction that ensures standardised scoring procedure which minimises intra and inter observer errors. It has 27 dental traits but now it has been expanded to more than 40 traits. They divided the world population in to Western Eurasian, African, Sunda Pacific, Sahul Pacifc and Sino- American. They also constituted a scoring sheet for maxillary (Figure No. 2) **(Scott, 1992)** and mandibular (Figure No. 3) dentition **(Scott and Irish, 2017).**

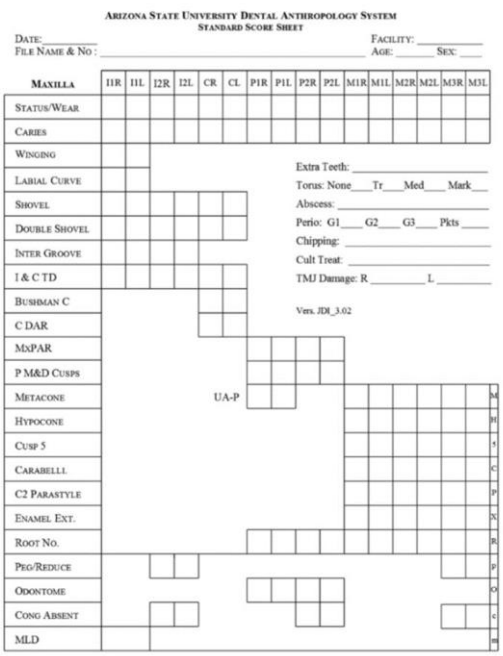

Figure No. 2: ASUDAS Scoring Sheet for Maxilla

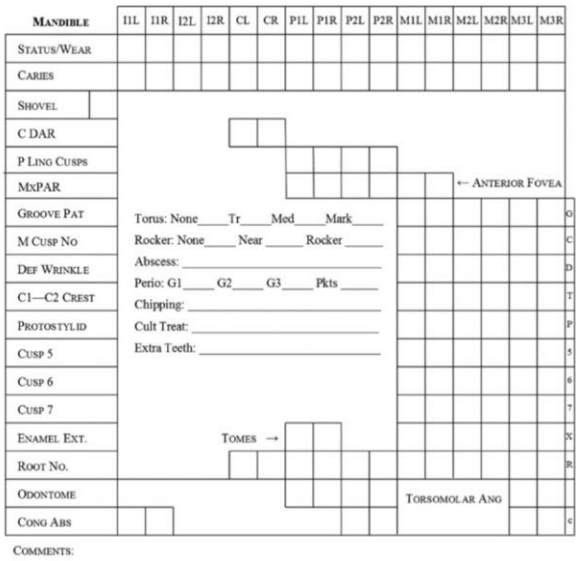

Figure No. 3: ASUDAS Scoring Sheet for Mandible

Scoring Procedure Using Asudas

- See for a trait
- Grade it according to the expression by referring ASUDAS plaques
- For expression 0-2, the trait is considered to be absent and the number 0 is given.
- For expression 3-6, the trait is considered to be present and number 1 is given.
- Then for a particular population, particular trait and numbers 1 and 0, there are values and each of the values are substituted in the formula for 100 and multiplied. The value probability (i) is derived.
- From that percentage of probability is achieved by dividing individual p(i) value by sum of P(i) value.

rASUDAS is an another web based application. The procedure is simple and it involves the scoring of different traits in the application and clicking the process tab in analysis part of the application for display of results.

Sex Determination

Sex determination is the second step in dental profiling. The sex determination can be done from

craniofacial features and certain parameters from tooth. The sexual dimorphism is the difference in their physical structure of male and female of same species other than their sexual characteristics. Table 1 shows craniofacial features of male and female skull **(Nagare *et al.*, 2019)**. Studies has shown 96% of accuracy from the skull. The logistic regression analysis using odontometry gave good results in sex determination **(Acharya *et al.*, 2011).** Many studies on canine mandibular index also gave good results for sex determination upto 74% and even 88% of accuracy with greater dimension in male.

Canine Mandibular Index = Mesio- distal crown width of mandibular canine/Mandibular canine arch width.

Table No. 1: The difference in skull morphology among male and female

Traits	Male	Female
Size	Big	Small
Architecture of skull	Rugged	Smooth
Cranial mass	Deeper	Less deeper
Temporal ridge	More prominent	Less prominent
Supraorbital margin	Round and dull	Sharper
Zygomatic bone	More pronounced	Less pronounced
Mandible	Squared	Rounded
Superciliary arch	Large and pronounced	Smaller
Gonian	Flared	Less flared
Teeth	Larger	Smaller
Mastoid	Medium-large	Small-medium
Nasal aperture	High, thin sharp margins	Lower, wider rounded margins
Mandible gonial angle	Less obtuse	More obtuse

The non- metric traits like distal accessary ridge in canine (Figure No. 4) and deflecting wrinkle in mandibular first molar (Figure No. 5) are seen in male population. Even if the mandible is completely edentulous the gonial angle of mandible helps in identification of the sex. The angle between 80- 90 degrees is for male and angle between 110-120 degress is for female population.

Figure No. 4: Distal Accessory Ridge in canine

Figure No. 5: Deflecting wrinkle in mandibular first molar

The forensic DNA profiling provides information on sex, parentage and species. Teeth plays a better source of DNA due to its hardness. It is seen in pulp and cementum. The intact teeth without any pathology, teeth retained in the sockets, multi-rooted teeth and even impacted tooth act as a good source of DNA. Crushing entire tooth, vertical split, horizontal section, endodontic access and cryogenic grinding are some of the technique used to extract DNA from the tooth. Once the tooth is selected, it should be decontaminated otherwise it affects the outcome of results from DNA analysis. It can be done using sodium hypochlorite or UV light. Thus DNA extracted from teeth can be analysed for sex chromosomes and AMEL genes to determine the sex. The AMEL genes are located in X and Y chromosomes of genes. Therefore male population have two non- identical AMEL genes and female population have two identical AMEL genes **(Alvarez-Sandoval *et al.*, 2014).**

The Incisor index by Aitchison (Ii= MD I2/ MD I1 X 100), higher in males and an another study of mandibular canine index gave an accurate results in Indian population. The value maximum of 7.1 mm was obtained for females and greater than 7.1mm for males.

Type I, I': Pattern dominant- female
Type II : Pattern dominant- female
Type III : Pattern seen- male
Type IV : Male
Type V : Varied Pattern- male

Same pattern in all quadrants- female

These two act as supplemental tool for sex determination.

The microscopic study of tooth for the presence of Barr bodies **(Barr *et al*., 1950)** and F bodies helps in identification of sex. The barr bodies can be extracted from tooth up to 400c whereas F bodies can be extracted even up to 1 year from a dehydrated pulp **(Duffy et al, 1991).**

Conclusion

Thus the Forensic Odontology uses these said applications of dentistry in investigation pertaining to the 'who' segment of exploration. The five stalwarts of non- metric dental traits and high percentage of results for sex determination obtained from the teeth plays a vital tool in post-mortem dental profiling.

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