Short Communication

Frontal Sinus and Nasal Septum Together in Forensics: Strengthening the Evidence for Personal Identification

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Frontal sinus being unique even for the monozygotic twins can serve as a forensic fingerprint in personal identification. Morphometric criteria to be useful in forensic odontology are that the structure should be unique and remain stable in lifelong process. Both these criteria are fulfilled by the frontal sinus and nasal septum. Frontal sinus has long been accepted as a valid tool for personal identification. Nasal septum and frontal sinus both can be classified from the same radiograph and being unique they both strengthen the evidence for positive personal identification. The radiographs full mouth CBCT, CT Scan head, PA radiograph are most commonly taken in dental setup and general hospital can serve as good markers to match ante and post mortem radiographs for personal identification. Frontal sinus and nasal septum have individual uniqueness and variability which shows good accuracy even for less sophisticated radiographic techniques and should be applied in most of the clinical situations.

Introduction

Human identification is of prime importance in mass disasters, road traffic accidents, fire accidents and in criminal case investigations. French police officer AlphonsoBertillion (1853-1914) created the first anthropometric scientific system based on physical measurements for identifying criminals in 1880 [1].

Fingerprint analysis, DNA matching, and anthropological studies can help in the process of individual identification. However, in cases of remains being burnt or decomposed, or where DNA is severely damaged, finger print analysis and DNA identification does not prove useful. In these cases, anthropological methods with the help of comparative radiography have proved to be a major tool. New sophisticated radiologic investigations add on to more accuracy while using these tools [2]

Frontal sinuses are a part of paranasal sinuses and are located in the frontal bone above each eye. Frontal sinus development begins around the 4th and 5th week of gestation and continues in intrauterine life, postnatal, puberty and early adulthood. Primary and secondary pneumatization continues from 2 years up to 18 years [3]. Frontal sinus morphometric classifications used for forensic applications are given by Yoshino, et al [4]. Taniguchi M, et al [5]. They are based on frontal sinus pattern such as symmetry of sides, aplasia, right or left dominance in combination with number of lobulations. Yoshinos frontal sinus pattern is established using following parameters 1. Frontal sinus size 2. Bilateral asymmetry 3. Superiority of size 4. Outline of upper border 5. Partial septa 6. Supraorbital cells. These parameters establish code number for individual which is unique. Taniguchi, et al. established frontal sinus pattern based on symmetry aplasia, right or left dominant asymmetry in combination with number of lobulation [5]. Frontal sinus apart from use in personal identification can also be used for age and gender determination [6]. Left frontal sinus size is found to be larger in males which size increases from 18 years to 60 years and decreases later with increase in age [6].

Nasal septum growth begins at 6th week of gestation and is completed by 18-20 years of age. Nasal septum shows variation and is classified as straight, simple deviation to right side or left, sigmoid type, reverse sigmoid type and other [5].

In addition, nasal septum and frontal sinus patterns were useful to establish identity in two forensic autopsy cases, showing ante- or post-mortem radiographs [5]. Frontal sinus patterns can significantly differ depending on the position of the head in radiographic examination. However, horizontal diameter of frontal sinus shows very little variance due to flat configuration of sinuses, and it may also be the case for horizontal deviation of nasal septum to left or right. Therefore, a combined use of frontal sinus and nasal septum patterns may be practical for identification by comparison of ante- and post-mortem frontal skull radiographs.

Various studies reporting successful use of frontal sinus in personal identification are Cameriere, et al. Kirk, et al. Christensens, et al. Kullman, et al. Marlin, et al. Quarter homme, et al. Nambiar, et al. Tangent, et al. Silva, et al. David & Runjhun, et al. and Victoria, et al [6]. Studies reporting use of Frontal sinus and Nasal septum pattern together for personal identification and their variability are published by P Verma, MP David, K Verma, Gopal KS, et al. Taniguchi, et al. Reddy S, et al.

Taniguchi M, et al. 2003 [5] suggested use of frontal sinus and nasal septum in personal identification and reported 204 different types of classification with high efficacy in identification with 95% probability.43% symmetry in Japanese population, 56.6% asymmetry. nasal septum straight in 13.4%, right deviation in 35.3%, left deviation in 37.6%, sigmoid in 6%, reverse sigmoid in 6.3%, other patterns in 1.4%.

MP David & Saxena, et al. [7] 2010 reported use of frontal sinus and nasal septum for personal identification. Out of 50 cases 9 cases were found to have identical pattern with 82% probability of positive personal identification. Symmetry of frontal sinus was found to be 58%, asymmetry in 32%, 6% of individual showing unilateral aplasia and 4% with bilateral aplasia. Nasal septum straight in 22%, right

deviation in 42%, left deviation in 30% sigmoid, reverse sigmoid and other pattern in 2%.

Reddy S 2014 [8] reported use of variability of frontal sinus and nasal septum for personal identification. Asymmetry seen in 71% and symmetry in 29% and straight nasal septum in 92.3% which varied from David, et al. and Taniguchi, et al. can be due to climatic and genetic factors.

P Verma, et al. 2015 [9] concluded there is significant correlation in patterns of nasal septum and Frontal sinus hence their combined use can be applied in forensics. Frontal sinus symmetry was observed in 78.5% and asymmetry in 7.3%. Aplasia bilateral and unilateral was noted in 5.3%, 8.7% in subjects respectively. Straight nasal septum most common followed by reverse sigmoid was noted.

K Verma, et al. [10] reported use of Frontal sinus and nasal septum (FS+NS) pattern in gender determination and personal identification with 54 unique patterns out of 80 cases.

Gopal KS, et al. [11] 2016 used CBCT images to establish pattern of frontal sinus and nasal septum and reported its possible applications for personal identification. Frontal sinus symmetry was observed in 43.75% individuals and asymmetry in 48.75%. Bilateral aplasia in 5% and Unilateral aplasia was seen in 2.5%. Straight nasal septum was seen in 33.75%, right deviation in 30%, and left deviation in 22.5% individuals. Sigmoid was seen in 5%, reverse sigmoid in 8.75%.

Frontal sinus can be a useful tool for personal identification its specificity is accepted by Kirk, et al. who reported the duration between ante and post mortem radiographs, age, gender and cause of death did not affect the accuracy for match [12]. Patil N, et al. [13], Kullman, et al. [14] reported 100% positive identification even in hands of radiologically inexperienced observers. Tatlisumak, et al. [15], Tang, et al. [16] reported that even though radiographic matching of frontal sinus is reliable method there is a chance of false positive results. Thus adding a parameter of nasal septum can add to strengthen evidence of positive human identification.

Frontal sinus and nasal septum are easily identifiable and can be accessed from one radiograph which is most commonly taken. Frontal sinus uniqueness and variability is proved mathematically [17], is relatively stable and has good level of accuracy even in hands of inexperienced observers [12].

Conclusion

Frontal sinus pattern matching can be reliable for personal identification for ages from 20 to 50 years of age but can be difficult due to technique sensitivity. Nasal septum with Frontal sinus adds more specificity for personal identification and both can be done on same radiograph, easy to identify and show uniqueness and variability. Hence nasal septum with frontal sinus pattern matching should be taken into consideration for identification of human remains for more accurate results.

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