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MORALITY VERSUS PROFIT.

The traditional methods used by forensic odontologists for identifying victims of mass disasters are being challenged by large multinational disaster management companies. Even where dental material is available, dental identification is being replaced by DNA analysis, a more expensive and time consuming laboratory technique. These companies who manage the disasters on behalf of the airlines/governments are sidelining the traditional methods of victim identification. As disaster managers, they take charge of DNA collection from families who have lost love ones but at the same time collect ante-mortem dental records, which they then keep safely in their possession. Not even police officers can coerce them into parting with these records. This raises moral issues which need to be addressed. Should dental identification, an accurate, cheap and fast method be replaced by an expensive and time consuming technique which swells the economic coffers of the large multinationals? The DNA analysis can take several months to complete, keeping families waiting long periods for confirmation of positive identification and the return of the mortal remains. Their justification is that no other method except DNA can identify the many different body parts that might be found at a disaster scene. The issues that have to be addressed are the following:

- Should whole bodies with good dental characteristics and ante-mortem records also wait for DNA identification?
- Should mutilated bodies with good dental characteristics and ante-mortem records not be identified by dental means and then kept until body parts are added when DNA analysis of the remaining parts is made known?
- The profession at large must determine how important it is for families to know if their next of kin have been positively identified (fast by dental means), versus getting every body part back after completion of DNA analysis months after the disaster.

The relevant authorities need to be aware of the identification capabilities of well trained forensic odontologists. We as a profession need to be adequately prepared to assist in the identification process in all eventualities, performing our duties in an efficient and professional way. DNA is unquestionably the method of choice when no dental or fingerprint material is available. If dental material or fingerprints are present, these methods should be encouraged on moral and ethical lines. The time has come for us to unite against those who wait like vultures to swoop down and make a quick buck out of the misfortunes of others. If we are not proactive in procuring a definitive role in mass disaster management we might find ourselves redundant in the future.

Bernitz H
President IOFOS

MOUTH WIDTH PREDICTION IN CRANIOFACIAL IDENTIFICATION: CADAVER TESTS OF FOUR RECENT METHODS, INCLUDING TWO TECHNIQUES FOR EDENTULOUS SKULLS

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ABSTRACT

An understanding of the structural relationships between the soft tissue anatomy of the face and the hard tissue anatomy of the skull is significant for craniofacial identification methods employed in forensic anthropology and forensic dentistry. Typically, mouth characteristics have been predicted from the teeth but this proves problematic in edentulous skulls. Some clue may, however, be provided by non-dental features. This study investigates the usefulness of the infraorbital and the mental foramen position for determining mouth width and additionally reports on accuracy tests using two other recently proposed methods that depend on the teeth: i) Krogman and İşcan's radiating mouth width prediction guideline; and ii) Stephan and Henneberg's 75% rule. Dissections of nine human cadavers indicate that the most accurate mouth width prediction method is the 75% rule (mean error of -2.4mm) followed by the distance between the infraorbital foramen (mean error of -3.3mm). Krogman and İşcan's radiating method, as interpreted by Wilkinson, underestimated mouth width by 7.3mm on average, while the distance between the mental foramen underestimated mouth width by 12.9mm. These results suggest that the infraorbital foramen can be used as a relatively good predictor of mouth width in edentulous skulls, however, the 75% rule should be given precedence if the dentition is present.
(J Forensic Odontotstomatol 2008;27:1:2-7)

Keywords: forensic science, facial approximation; video superimposition, facial reproduction; facial reconstruction; forensic anthropology

INTRODUCTION

Knowledge of the relationships between the soft tissues of the face and the skull is important for craniofacial identification techniques and for medical surgery.[1,2] In craniofacial identification, the positional relationships of superficial soft tissue structures of the oral region (e.g. the cheilions and the vermillion border height) have typically been assessed in relation to the dentition.[3-7] In contrast, the cheilion points have been used to predict certain hard/soft tissue features in medical surgery (such as skull foramina to estimate nerve positions).[2] This "reverse" approach to predict hard tissue features has relevance to craniofacial identification since the logical sequence of the relationship can be inverted (i.e. the mental foramina can be used to predict the cheilion points) and because non-dental landmarks hold potential for soft tissue prediction on edentulous skulls.

In a study of fifty cadavers Song *et al.*[2] found that the infraorbital foramen lay within the same vertical plane as the cheilions in 50% of cases, and that the distance between the infraorbital foramen overestimated actual mouth width by 0.6mm (mean = 54.9mm; SD = 3.4mm in contrast to the actual mouth width values of 54.3mm, SD = 5.5mm). The distances between the mental foramina were, however, significantly shorter than the inter-cheilion distances (mean width = 47.2 mm, SD = 3.4mm, in the former).[2]

In terms of the teeth, it has been unequivocally shown that the chord length between the lateral aspects of the canines produces inaccurate estimates of mouth width.[8,9] To accommodate for this, Stephan and Henneberg[10] proposed a 75% rule where the inter-canine distance is taken to represent three-quarters of the total mouth width. Alternatively, Wilkinson[11,12] claims that a direct relationship between the canines and the cheilions exists, so long as the cheilions are placed along reference lines which radiate from the canines at angles perpendicular to the contour of the dental arcade. This suggestion is based on the original directions by Krogman[3] who first proposed the guideline but did not state at what angles the radiating guidelines should be positioned from the skull. Although Wilkinson indicates that this "radiating guideline" is accurate and thus "very useful",[11,p.329] it has not been subject to formal empirical tests. Furthermore, Stephan and Henneberg's rule has not been tested on other samples beyond those on which it was originally formulated. This study, therefore, aims to examine the feasibility of using the infraorbital and mental foramina to predict the mouth width and tests Stephan and Henneberg's 75% rule along with Krogman and İşcan's "radiating" guideline (as couched by Wilkinson).

MATERIALS AND METHODS

Nine embalmed cadavers of European extraction (6 males, 3 females) ranging in age from 62 to 94 years (mean = 78 years, SD = 10 years) were examined in this study. All heads were sectioned from the body just below the mandible and prior to and during investigation they were stored in an upright position without pressure to the face. Essentially all cadavers had their mouths in the closed position so that the gap between the superior and the inferior labia was less than five millimetres - only one subject was an exception to this observation.

At dissection, almost all of the lower lip, except its lateral edges near the cheilion, and the soft tissue covering the chin was removed (Fig. 1). This enabled a clear view of the cheilion points and the maxillary teeth. Dissection windows were also cut superficially to the mental and infraorbital foramina to allow observation of these skeletal features (Fig. 2). Special care was taken during these manoeuvres so as not to move the mandible or compress the intact soft tissues of the lips.

When removing the lower lip, it was found that the true anatomical position of the cheilion, i.e., where superior and inferior labia meet at the lateral points of the labial commissure,[13] was not evident from a frontal view because these points were obscured by overhang of the lips in the mouth shut position. The true junction of the labium superious and inferious was therefore located posteromedially to the "visible" cheilion point (as identified superficially in a frontal view). Since the "visible" cheilion is commonly used in facial approximation, we based all of our measurements to this point by following out from the anatomical cheilion, a tangent that bisected the curve of the dental arcade and which crossed the vermillion border of the upper lip (Fig. 1). This method enabled a precise determination of the cheilion within the soft tissue funnel at the lateral aspects of the mouth.

Upon dissection many of the specimens were found to have reabsorbed mandibles associated with tooth loss. Only three subjects were found to have intact dentition from which the position of the canine/premolar junction could be identified and the mental foramina could not be measured on one specimen due to obliteration of these landmarks in a prior study (partial removal of the mandible). Sample sizes, therefore, fluctuate in this study depending on which mouth width prediction method was being considered.

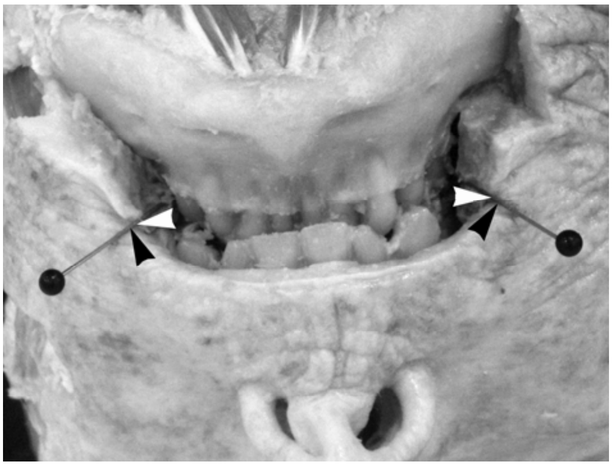

Fig.1: *Inferior view of a cadaver specimen after removal of the center region of the lower lip leaving cheilion points intact. The white arrows point to the cheilion point as anatomically determined from the junction between the superior and inferior labia. The black arrows point to the "visible cheilion" points which are evident in a frontal view when the upper and lower lips are closed and obscure the anatomical cheilion points.*

The following distances were measured to enable targeted comparisons: i) mouth width; ii) distance between the lateral extents of the canine teeth; iii) inter-infraorbital foramina distance; and iv) inter-mental foramina distance (Fig. 2). The predicted mouth width according to the "radiating guideline" was also measured after this distance was established by placing pins at the canine/1st premolar junction and at angles that bisected and radiated out from the dental arcade (Fig. 2), thus following directions of Wilkinson.[11, p.329; 12, pp.116 & 117] Note here that the positions of the cheilion points and the foramina of the skull were also measured along a Cartesian grid with the zero point registered on the anterior nasal spine. All measurements were made using GPM® sliding calipers to the nearest half a millimetre.

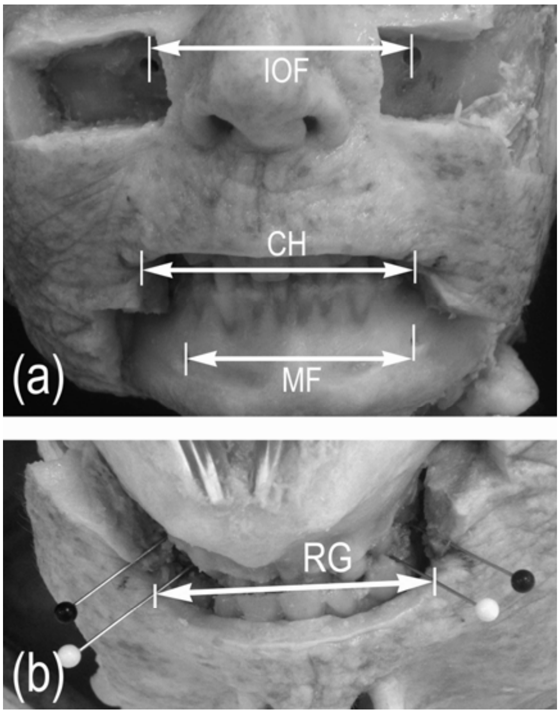

***Fig.2:** Linear distances recorded in this study. (a): IOF represents the distance between the center points of the infraorbital foramina; CH represents the distance between the "visible" cheilion points; MF represents the distance between the center points of the mental foramina. (b): RG represents the mouth width determined according to Krogman and İşcan's[4] and Wilkinson's[11,12] directions. The dark pins represent those used to determine the actual (non-predicted) cheilion position in the cadavers. Note here that positioning of the tangents was very carefully determined on the specimens. Impressions from the photographs that small deviations may have been made from Wilkinson's recommended angulations are the result of photographic angle. "Straight-on" views proved to be insufficient for illustration purposes because other pertinent landmarks (such as the teeth in the dental arcade) were shielded from view by the mandibular border.*

To insure internal repeatability of the measurements, a second set of measurements were taken six days following the first to determine intra-observer error. The intra-observer error was calculated by taking the sum of the squared differences between test and retest and dividing it by two times the number of remeasured individuals. The square root of the result (i.e., of the technical error of measurement[14]) was then divided by the mean of the test/retest result of the first individual to generate a coefficient of variation of the error.

RESULTS

Measurement errors for all variables assessed in this study were less than 3%. The mean mouth width for all nine cadavers was 55.1mm, SD 4.4mm. This value is in the same vicinity as that reported by other authors[8,9,15,16] although it is towards the upper end of the spectrum. The mean width between the lateral aspects of the canines as measured in three individuals was 40.8mm, which falls well short of typical mouth widths noted in other studies.[8,9] In this sample, the canine width represented 72% of the mouth width (see Table 1), approximating the 75% reported by Stephan and Henneberg.[10] The error resulting from use of the 75% rule was -2.4mm for the three individuals for whom mouth width and canine width could be measured.

The "radiating guideline" produced mouth width estimates of 49.5mm, which underestimated the measured mouth width by 7.3mm in the three individuals where these values could be taken. If the radiating lines from the canine/first premolar junction were forced to cross at the true cheilion points to reduce the error, then their angulations would clearly need to be increased in contrast to the "perpendicular" angles recommended in the literature (see Fig. 2). The distance between the infraorbital foramina underestimated actual mouth widths by a mean value of 3.3mm, while the distance between the mental foramina underestimated the mouth width by 12.9mm (see Table 1). These values are slightly larger than those reported by Song and colleagues,[2] but follow the same general pattern with the mental foramina distance diverging most from the mouth width. The positions of the cheilion points, infraorbital foramina and mental foramina relative to the anterior nasal spine are illustrated in Figure 3.

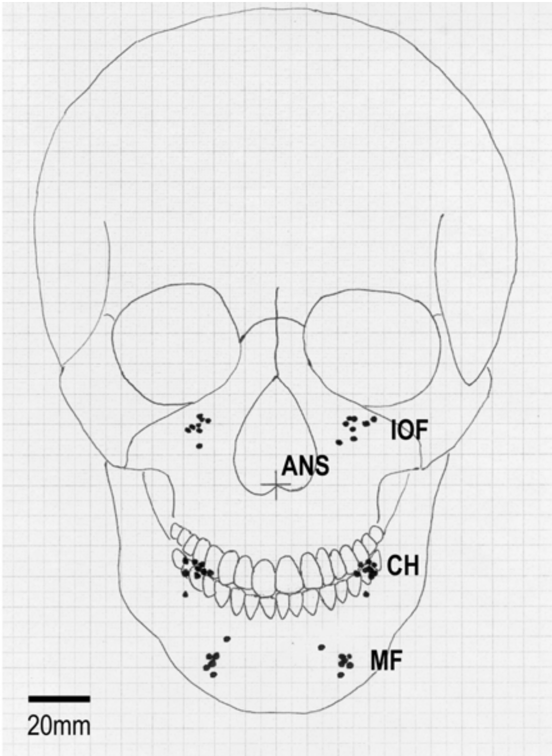

Fig.3: *The position of the infraorbital and mental foramen recorded in this study in reference to the position of the anterior nasal spine.*

In summary, this study found that Stephan and Henneberg's 75% prediction rule underestimated mouth width in this sample by 4%, the inter-infraorbital distance underestimated mouth width by 6%, Wilkinson's interpretation of Krogman and İşcan's radiating guideline underestimated mouth width by 13%, and the inter-mental foramina distance under-represented mouth width by 23%.

DISCUSSION

Since the findings of this study are based on a small sample the results cannot be generalized to the larger population, however, these data irrespectively provide useful indicators about the errors involved in mouth width prediction and therefore hold pertinence to craniofacial identification methods. First, they lend support towards Stephan and Henneberg's 75% prediction rule as being accurate and support its continued use when the dentition are present. Second, they suggest that mouth width can be accurately predicted using non-dental cranial landmarks (i.e., the infraorbital foramen). Third, they demonstrate that the radiating mouth width prediction guideline is probably not as Wilkinson propounds[11, p. 329] "a very useful facial reconstruction standard" - in all three individuals examined here, this guideline performed well outside the typical 5% level for error tolerance in scientific investigations.

It may be possible to further improve the prediction of mouth width using the distance between the infraorbital foramina by adding 3.3mm to the measured distance in anticipation of its underestimation. However, the value of such an adjustment is difficult to comprehensively assess in a small sample where reliable correlation coefficients cannot be generated. Further studies in larger samples are necessary to verify any benefits of such an approach. Adjusting Krogman and İşcan's guideline in a similar fashion does not seem to be of value, since it is already complex, subjective, and not easily applied. Its greatest limitations are that the cheilion points are not located on tangents which radiate from the dental arcade at angles that bisect its curvature and that this guideline depends on soft tissue depth values at cheilion which have never been empirically quantified (for a review of the measured facial soft tissue landmarks in over sixty studies see Stephan and Simpson[17]).

It is worth noting here that while the interpupillary distance has been found to over estimate the mouth width by 11mm,[8] recent studies have found that traditional methods for eyeball placement in facial approximation underestimate interpupillary distance by c. 5mm.[18,19] Therefore, the use of the interpupillary distance to estimate the mouth width in past facial approximation methods is likely to produce smaller errors (c. 5mm) than those reported for investigations of living persons, but the problem of erroneous eyeball positioning remains inherent to these facial approximation techniques. In addition, the underestimation of the interpupillary distance in traditional facial approximation methods exacerbates the underestimation of the mouth width if the medial limbus or edge of the iris is used for mouth width prediction. Thus, while in living subjects the distance between the medial edges of the iris approximates the mouth width rather well,[8] the accuracy of the method is diminished when the eyeballs are inaccurately placed in facial approximation - the total error will approximate 7mm, with the 5mm error introduced by central globe positioning summing with the 2mm underestimation that results from use of the medial iris edges.[see8,18,19]

Further studies elucidating the exact nature of the anatomical relationships between the hard and soft tissues in other regions of the face are needed to reduce the subjectivity of the facial approximation method. Recent findings of considerable inaccuracies in traditional face prediction/assessment methods sets a track record that supports continued efforts in this direction.[8, 9, 18, 20-23] While computer analysis has been heralded as a silver bullet to circumvent many of the problems inherent to facial approximation methods (especially subjectivity),[24] blind use of abstract-mathematical procedures (such as warping of surface meshes) risks the production of faces that are anatomically implausible in their detail. Thus, while computerized approaches are widely recognized to hold many advantages, care should be taken to ensure that the generated faces hold internal anatomical validity. This further justifies anatomical studies of craniofacial relationships in an attempt to improve craniofacial identification techniques.

Table 1: *Mean mouth widths and descriptive statistics for variables measured in this study.*

	Inter-canine distance	**75% rule**	**Radiating Guideline**	**Inter-infraorbital foramina distance**	**Inter-mental foramina distance**
Sample Size (n)	3	3	3	9	8
Mean	40.8	54.4	49.5	51.8	42.0
Standard deviation	0.8	1.0	0.9	3.6	1.7
Median	41.0	54.7	50.0	51.5	42.0
Min.	40.0	53.3	48.5	47.0	39.0
Max.	41.5	55.3	50.0	57.0	44.0
Mean Mouth Width	56.8	56.8	56.8	55.1	54.9

REFERENCES

1. Stephan CN. Craniofacial identification: Techniques of facial approximation and craniofacial superimposition. In: S Blau, DH Ubelaker. Eds. Craniofacial identification: Techniques of facial approximation and craniofacial

   superimposition. Walnut Creek: Left Coast Press, 2008. In press.

2. Song W-C, Kim S-H, Paik D-J, Han S-H, Hu K-S, Kim H-J, Koh K-S. Location of the infraorbital and mental foramen with reference to the soft-tissue landmarks. Plast Reconstr Surg 2007;120:1343-7.

3. Krogman WM. The human skeleton in forensic medicine. Illinois: Charles C Thomas, 1962.

4. Krogman WM, İşcan MY. The human skeleton in forensic medicine. Illinois: Charles C Thomas, 1986.

5. Prag J, Neave R. Making faces: Using forensic and archaeological evidence. London: British Museum Press, 1997.

6. Gatliff BP. Facial sculpture on the skull for identification. Am J Forensic Med Pathol 1984;5:327-32.

7. Taylor KT. Forensic art and illustration. Boca Raton: CRC Press, 2001.

8. Stephan CN. Facial approximation: An evaluation of mouth width determination. Am J Phys Anthropol 2003;121:48-57.
9. Wilkinson CM, Motwani M, Chiang E. The relationship between the soft tissues and the skeletal detail of the mouth. J Forensic Sci 2003;48:728-32.

10. Stephan CN, Henneberg M. Predicting mouth width from inter-canine width - a 75% rule. J Forensic Sci 2003;48:725-7.

11. Wilkinson C. Facial approximation: Comments on Stephan (2003). Am J Phys Anthropol 2004;125:329-30.
12. Wilkinson C. Forensic facial reconstruction. Cambridge: Cambridge University Press, 2004.

13. Farkas LG. Anthropometry of the head and face. New York: Raven, 1994.

14. Dahlberg G. Statistical methods for medical and biological students. London: George Allen & Unwin, 1940.

15. Ferrario VF, Sforza C, Poggio CE, Serrao G. Facial three-dimensional morphometry. Am J Orthod Dentofacial Orthop 1996;109:86-93.

16. Ferrario VF, Sforza C, Serrao G. A three-dimensional quantitative analysis of lips in normal young adults. Cleft Palate Craniofac J 2000;37:48-54.

17. Stephan CN, Simpson EK. Facial soft tissue depths in craniofacial identification (part i): An analytical review of the published adult data. J Forensic Sci 2008; In press.

18. Stephan C, Davidson P. The placement of the human eyeball and canthi in craniofacial identification. J Forensic Sci 2008; In press.

19. Stephan CN, Huang A, Davidson PL. Further evidence on the anatomical placement of the human eyeball for craniofacial identification. J Forensic Sci 2008; In review.

20. Wilkinson CM, Mautner SA. Measurement of eyeball protrusion and its application in facial reconstruction. J Forensic Sci 2003;48:12-6.

21. Stephan CN. Facial approximation: Falsification of globe projection guideline by exophthalmometry literature. J Forensic Sci 2002;47:1-6.

22. Stephan CN, Henneberg M, Sampson W. Predicting nose projection and pronasale position in facial approximation: A test of published methods and proposal of new guidelines. Am J Phys Anthropol 2003;122:240-50.

23. Rynn C, Wilkinson CM. Appraisal of traditional and recently proposed relationships between the hard and soft dimensions of the nose in profile. Am J Phys Anthropol 2006;130:364-73.

24. Clement JG, Marks M. Computer graphic facial reconstruction. Boston: Academic Press, 2005.

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RADIOGRAPHIC DENTAL IMPLANTS RECOGNITION FOR GEOGRAPHIC EVALUATION IN HUMAN IDENTIFICATION

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ABSTRACT
Dental implants for prosthetic rehabilitation with fixed crown or mobile partial/total dentures is a very common oral treatment among the population in Italy as elsewhere. There is a great number of implant systems of different designs. However, a catalogue of radiographic images and a description of the dental implants available in Italy would be useful in order to identify the manufacturer and the type of implant encountered in forensic casework. When an unidentified body is found with one or more implants in the jaws, and no dental record is available, clues gleaned from the type of implants used could give direction to the investigation.

In this study Italian implant manufactures were contacted and asked to provide specimen implants. Digital radiographs were taken of all the implants donated at 0º, 30º, and 60 º horizontal rotation, combined with -20º, -10º, 0º, +10º, and +20º vertical inclination relative to the radiographic beam and the X-ray sensor. A total of 15 images per implant were taken and examined to identify consistent, unique features that would aid in implant recognition. Only those observations made from radiographs between -10º and +10º vertical inclination would ever be used for definite identification of any implant.

The information from this study should be considered a survey of the commercial distribution of dental implants in Italy through their digital radiographic images. It is also a starting point for a wider geographical evaluation of different manufacturers in other countries and continents. The radiographic images provided should help both the forensic odontologist and the prosthodontist to identify pre-existing implants which they may discover from their radiographic images.
(J Forensic Odontostomatol 2008;27:1:8-11)

Keywords: dental implants, forensic odontology, human identification, dental records

INTRODUCTION
Dental prosthetic rehabilitation with oral implantology has become a very common treatment choice among the Italian population, as in the rest of the world. It is a direct consequence of modern dentistry to promote dental implants, as surgical technique and results have become more predictable and costs have been reduced, making this treatment generally affordable to every patient. Dental implants can be juxtaosseous or endosseous. The type of dental implants accepted by the scientific dental community are endosseous titanium screws or cylinders, with a rough surface, etched or titanium plasma sprayed. A great number of implant systems with different designs have been manufactured. Some of them are leading worldwide manufacturers and thus are distributed in many countries. Nevertheless, increasing demand from the domestic dental market has seen many national implant system manufacturers responding to international competition, and developing systems of their own. In this regard Italian dental implant manufacturers have a unique design and generally have a national distribution. For this reason we believe a creation of an Italian radiographic dental images' catalogue would assist the human forensic identification process allowing manufacturer recognition and a geographical evaluation.

Identification of human remains is accomplished by fingerprint, dental, anthropological, genetic and radiological examination. Human bones and teeth survive both natural and unnatural processes and therefore can nearly always be examined radiographically[1]. In 1992 Sewerin[2] first described and analyzed radiographic images of ten dental implants from different viewing angles. The aim of the study was to identify implants previously inserted by other dental surgeons to help the clinician in their prosthetic final work. Increased patient mobility, and the large number of implants systems with different designs, has determined the need for a radiographic catalogue of dental implant images.[3,4] Unfortunately, it is rather difficult to keep up with the continuous development of new implants. The identification of old and new dental implants can become a problem for the dentist treating a patient with no dental records available and also for the forensic odontologist while attempting the identification of an unknown cadaver.[5] Forensic dental identification is based on the morphological comparison and matching of dental records, mainly available as radiographic images.[6,7] Postmortem dental records are compared with ante-mortem records pertaining to some presumed identity.[7] However, if no previous papers are found identification may be difficult. Morphological features of dental implants depicted on radiographs may be used to develop a dental profile of the individual and provide information that can narrow the search to a smaller number of individuals, or eliminate certain candidates by taking into account the dental system employed.[8-10] The matching of two sets of radiographs is performed with post mortem periapical X-ray of the implants against the dental implants' images of the various implant systems stored in the archive. Some implant systems have peculiar characteristics making recognition easy, but others which share very similar characteristics, require the analysis of fine structures[11].

The aim of this study is to create an archive of radiographic images of Italian dental implants to be employed in forensic caseworks to narrow the investigation of unidentified victims with one or more dental implants. Investigators should be able identify the type of implant by comparing radiographic images, thus narrowing the search.

This archive would represent a starting point for a wider dental implant archive and geographical evaluation in other countries.

MATERIALS AND METHODS

In this study Italian implant manufactures, advertised in professional national journals, were contacted and asked to provide specimen implants of various diameter, but all as close as possible to 10 mm in length. At present 10 Italian manufacturers (Sweden & Martina, Micerium, Endoimplant, Geass, Primary Healing Implant PHI, Life Support Systems LSS, Leone, Leader Italia, Krugg, IdiEvolution) have replied and sent multiple implants of various design. A device was fabricated to make standardized radiographs at different vertical inclinations and horizontal rotations. This range of angles is meant to mimic clinical situations as implants are inserted in the jaws by the dental surgeon with various angulations and thus determine a different radiographic image. Digital radiographs were taken of all the implants donated at 0 º, 30 º, and 60 º of horizontal rotation combined with -20º, -10º, 0º, +10º and +20º vertical inclination relative to the radiographic beam and the X-ray sensor. A total of 9 images per implant were taken and catalogued. All radiographs were made in the same sequence, starting at 0° horizontal rotation and 0° vertical inclination. Thereafter, the inclination remained constant and the rotation was changed to 30° and 60°. The vertical inclination was then changed to +10° (10° toward the cone) and -10°. In fact we decided that only those observations made from radiographs between -10 º and +10 º vertical inclination would ever be used for definite identification of any implant. The digital image obtained was in TIFF format and was named with the position parameters, and then all pictures of the implant were inserted in a folder named with the manufacturer and the type of implant. Observations were also recorded on a data collection sheet to verify the correct sequence and avoid mislabeling of the image file.

All radiographs were made with a Trophy X-Ray appliance and Trophy Radiovideography sensor connected to a computer, using 0,02 seconds exposure time and 68 Kv.

RESULTS

Digital images in TIFF format were compiled for inclination from -10° to +10° and for 0°, 30° and 60° of rotation. An archive of 9 images per implant type was stored together with the implant system name (Figs.1 and 2). The images archive has been duplicated also into JPG format and saved in a cd available to forensic odontologists upon request. As the archive is composed of several hundred radiographic images, only four examples were chosen.

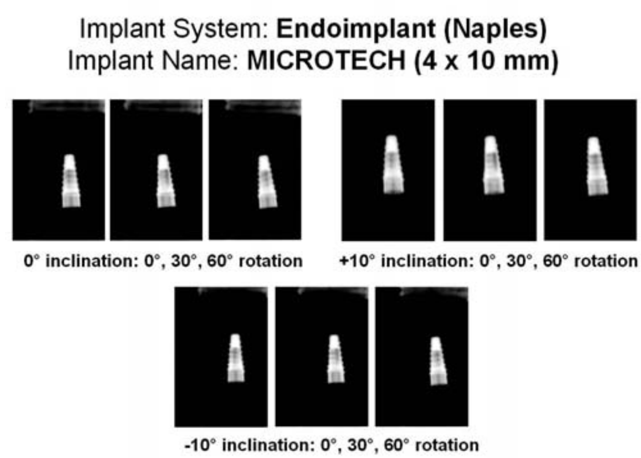

Fig.1: *Examples of the nine images archived per each implant stored in the database together with the implant system name.*

DISCUSSION

Knowledge of implant designs and implantology is fundamental for the radiographic recognition of the implant system. Familiarity with implant design not only helps with radiographic identification but also may be an asset in radiological procedures and techniques. During the post mortem implant radiography the positioning of the X-ray device and sensor has to reproduce the geometry of the implant design most adaptable to the comparison against our implants X-ray images' archive[12]. This has also to take into account the muscular rigor mortis. For this reason it is important, in a real identification case, to get as many different X-ray projections so that a clear geometrical implant image is obtained but also certain implant details are revealed.

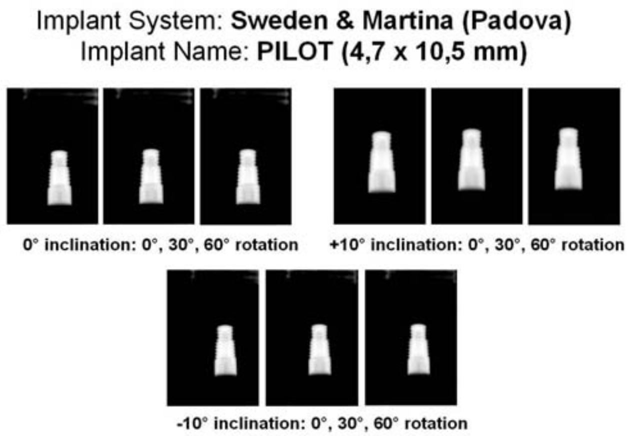

Fig. 2: *Examples of the nine images archived per each implant stored in the database together with the implant system name.*

Some implants have perforations, grooves, apical chambers, and threads which are visible only at certain rotation or angulations (Fig.3). These features may be unique and enable recognition of specific products. Some other features may confuse the interpretation of an implant which is a clone of another more diffused large international implant company. Yet the present is intended to create only a radiographic images database, with no design description, of dental implants manufactured in Italy

Due to the great number of implant systems available on the market and to the continuous development of new dental implants, designs, we cannot consider our archive to be complete. For this reason the collection of Italian dental implants has to be considered as ongoing research. An update of the archive will be available every 12 months with newly designed implants or implant systems not included in the present study.

For the purpose of this work and the necessity of data transmitting, the use of digital X-ray is necessary and cannot be substituted by traditional X-ray processing.

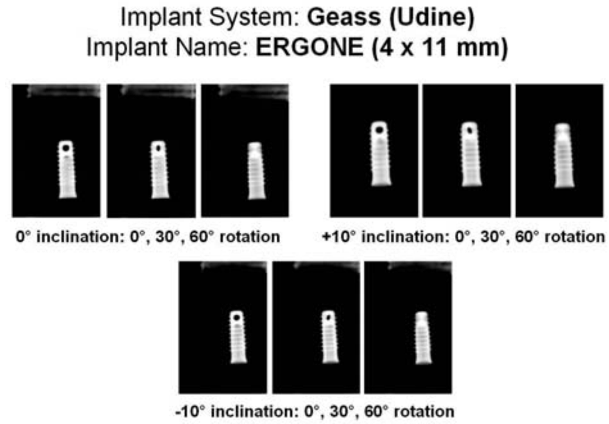

Fig. 3*: Example of dental implant with apical perforation visible only at certain rotation.*

CONCLUSION

The information from this study should be considered a survey of the commercial distribution of dental implants in Italy through their digital radiographic images. It should help both the forensic odontologist and the prosthodontist to identify pre-existing implants which may be discovered from their radiographic images.

In the human identification process of unknown victims with no dental records available, the recognition of dental implants detected may give auxiliary information to narrow the search to a smaller number of individuals or eliminate certain candidates altogether. In performing the forensic evaluation and superimposition, forensic odontologists must be familiar with implant designs and implant therapy.

In order to cover as many as possible of the implant systems available in Italy our research should be considered a work in progress, and the archive has still to be enlarged. A worldwide radiographic implant image database, including similar “cloned” implants, is needed for a wider geographical evaluation of the different manufacturers in other countries.

DISCLOSURE

The authors highlight they have no commercial benefits or interests with dental implants' manufacturers employed in this work.

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REFERENCES

1. Kahana T. Hiss J. Identification of human remains: forensic radiology. J Clin Foren Med 1997;4:7-15.

2. Sewerin I. Identification of dental implants on radiographs. Quintessence Int 1992;23:611-8.

3. Sahiwal IG, Woody RD, Benson BW, Guillen GE. Radiographic identification of threaded endosseous dental implants. J Prosthet Dent 2002;87:563-77.

4. Sahiwal IG, Woody RD, Benson BW, Guillen GE. Radiographic identification of nonthreaded endosseous dental implants. J Prosthet Dent 2002 May;87:552-62.
5. Sahiwal IG, Woody RD, Benson BW, Guillen GE. Macro design morphology of endosseous dental implants. J Prosthet Dent 2002;87:543-51.

6. Tai CC, Blenkinsop BR, Wood RE. Dental radiographic identification utilizing computerized digital slice interposition: a case report. J Forensic Odontostomatol 1993;11:22-30.

7. Jain AK, Chen H. Matching of dental X-ray for human identification. Pattern Recognition 2004;37:1519-32.

8. Pretty IA, Addy LD. Associated post-mortem dental findings as an aid to personal identification. Sci Justice 2002;42:65-74.

9. Bell GL. Dentistry's role in the resolution of missing and unidentified persons cases. Dent Clin North Am 2001;45: 293-308.

10. Zhou J, Abdel-Mottaled M. A content-based system for human identification based on bitewing dental X-ray images. Pattern Recognition 2005;2132-42.

11. Sainio P, Syrjanen SM, Komakow S. Positive identification of victims by comparison of ante-mortem and post-mortem dental radiographs. J Forensic Odontostomatol 1990; 8: 11-6.

12. Georget G, Fronty P, Sapanet M. L'identification comparative. Fontaine Imprimeur - Poitier 2001;55-9.

13. Gruber J, Kameyama MM. Role of radiology in forensic dentistry. Pesqui Odontol Bras 2001;15: 263-8.

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FORENSIC ODONTOLOGY IDENTIFICATION USING SMILE PHOTOGRAPH ANALYSIS – CASE REPORTS

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ABSTRACT

The identification of unknown human by smile photographs that show specific characteristics of each individual has found wide acceptance all over the world. Therefore this paper shows this situation reporting different cases which smile photograph analysis were crucial to determine the positive identification of unidentified human bodies. All the cases were subjected to personal identification by photographs of smile including one adult male found in an advanced stage of decomposition, one adult female disappeared during an ecotourism trip, and one carbonized body of a male individual found in a forest region. During the autopsy the photographs of the smile were used by comparison of the ante and postmortem images gave accurate and useful information not only about dental state but also the anatomical features surrounding the upper and lower anterior dental arches. This method is not time-consuming and also has the advantage of allowing extraoral dental examination. It is also recommended when there is a need to provide quantitative data for a forensic identification based on these structures. **(J Forensic Odontontostomatol 2008;27:1:12-17)**

Keywords: human identification, smile photograph, forensic odontology

INTRODUCTION

The identification of human bodies that are carbonized, mutilated or skeletonized or in the process of decomposition, through the analysis of dental characteristics is a common task for the medical legal department[1]. Thus, it is necessary that experts seek from family members any type of odontologic documentation that contains diverse identification characters of the individual to be identified.

Among the documents most frequently used to help forensic odontology task are the dental records, patient records,[2] cast models,[3] intraoral photographs,[4] periapical radiographs,[5, 6] interproximal and panoramic radiographs[7] and postero-anterior skull radiographs.[8]

However, in certain cases, the victim being analyzed may not have clinical records showing relevant odontologic characteristics. Therefore, experts in the practice of human identification currently search for information from alternative sources, such as facial photographs,[9] video recording[10] or smile photographs[11] that show specific characteristics of each individual.

Considering the importance of searching for new parameters of human identification using odontologic characteristics, the aim of the present work was to point out, by means of three criminal investigation cases, the importance of the forensic odontology analysis of smile photographs in human identification.

CASE 1

A male subject showing compatible age with the transition between adolescent and adult, was found in an advanced stage of decomposition. During forensic odontology examination, it was noted that the individual had practically healthy-appearing remaining dental elements, where only the upper left central incisor (21*, FDI notation) was absent, with characteristics compatible of former dental loss while still alive. In this region, the alveolar process appeared to have undergone remodeling and part of the mesio-distal space was found to be partially preserved (Figs.1A,1B). The police investigation found that a male with anthropologic characteristics matching those of the recovered body had disappeared in the same region for a few days. In attempts of finding the missing person, family members had distributed around the area some posters with his photograph. This picture in the poster showed the missing person smiling, and a study of the anterior maxillary region, showed evidence that he was also missing a tooth in the region of 21* (Fig.1C). Based on this evidence and due to the fact that no type of odontologic records could be found, the photograph in the poster and the skull image of the corpse were compared by computerized superposition of the images, in addition to DNA analysis, confirming that the body was the person who had disappeared.

CASE 2

A Russian origin adult female disappeared during an ecotourism trip. Some posters containing information and photographs of the missing person had been distributed in the city where she was last seen, where two of these photographs showed the smile of the woman (Figs.2A,2B). However, the investigations only effectively developed almost one year after the disappearance date, when the suspect in the murder of the victim was arrested and indicated the location where the body's victim was hidden. Based on this information, the police involved in this case was able to find the skeletal remains. Forensic odontology investigation showed that the inter-arch relationship was an Angle Class II type, demonstrating significant horizontal cross bite, upper incisor overjet, and upper central inter-incisor diastema. Besides that it was noted a wearing on the incisal face of the upper right central incisor, as well the upper left central incisor and the upper left lateral incisor (11*, 21* and 22*), (Figs.3A,3B). With the skeleton was found a removable orthodontic retainer which fit the upper dental arch (Fig.3C). Combining the techniques anthropologic analysis (sex, age and stature determination), computerized superimposition of the skull images and photograph of face, analysis of information contained in odontologic clinical dental records and smile photograph, a positive identification was made of the skeleton examined as the missing person.

CASE 3

The carbonized body of a male individual was found in a forest region and sent for anthropologic and forensic odontology examination. The autopsy examination revealed skull bone fractures with exposure and loss of encephalic material, absence of the arms, presenting calcination zones in the osseous extremities and disarticulated lower limbs. Investigation with the presumed family located odontologic documentation (clinical records and periapical radiographs), two radiographs of the right upper arm and a smile photograph. This photograph showed the anterior upper teeth, indicating the absence of upper right and left first premolars (14* and 24*) and evidence of amalgam restoration on the mesial face of upper left second premolar (25*) (Fig.4A). All these indications had been confirmed during forensic odontology examination (Figs.4B,4C), which combined with the data present in the medical and odontological records, showed a positive correlation between the identity of the missing victim and body examined.

DISCUSSION

Human identification in which the body's soft tissues have been destroyed normally requires a multidisciplinary approach, where forensic odontology, forensic anthropology and molecular biology (DNA studies) are the most effective in establishing a positive correlation between a recovered body and the identity of a missing person.

In the presented cases, the three cited methods can make it possible to obtain a positive identification of the victim, with reliable results. However, each one of them possesses advantages and disadvantages when considering the type of techniques used, the time required and mainly the operating costs to obtain the results. DNA analyses, specifically, requires the expert to work with mathematical precision for establishing a genetic link or not between a questionable biological sample and the standard, or between biological samples of a disappeared individual (corpse) with samples from relatives.[12] However, the reliability of results is based on considerable operating costs (equipment, reagents and consumables) which are currently not yet included in the routine practice of the majority of official criminal investigation agencies.

In the analysis of corpses considered "unidentifiable", forensic odontology techniques stand out over other methods because of the low operating costs, fast analysis and interpretation of the data, and high reliability of the results. Therefore, it is highly desirable that new forensic odontology parameters be developed to identify odontologic characteristics that are unique for each individual. Concerning that matter MacKenna (1986) in his Master thesis refers to William Ockham (1270-1349) that said "What can be done with fewer assumptions is done in vain with more"[11].

However, as with the many methods used in human identification, traditional forensic odontologic techniques can be at times unsuitable for various reasons. Among them there are situations such as: extensive destruction of the bucco-maxillofacial complex, lack of dental records and when information from available dental records is irrelevant to investigation. Exactly in the case of these last two possibilities, it could be interesting to examine photographs from family albums or of social events in which the missing person participated. The justification is based on the shape, dimensions and alignment of the teeth of an individual, which can comprise a specific and unique set.[11] Moreover, there has been a growing trend in the popular use of digital cameras, where the main focus is centered on the face of the individuals, more specifically on the smile.

The dental analysis of the smile constitutes a current concern of specialties that include aesthetic dentistry.[13] established the importance of diagrams of dental aesthetic reference (DDAR), where a smile can reveal dental relationships of symmetry, dental axes, gum contours, inter-dental contacts, incisal edges, teeth proportions and smile lines.

In this manner, orthodontics is one of the fields that deals with extensive clinical documentation of the dental elements that determine the smile of individuals, as it uses and needs complete odontologic documentation, including digital or analog photographs,[14] for the planning and execution of treatments.

The increased use of intraoral photographs for clinical purposes, along with the popularization of digital cameras, is providing more material with potential value for forensic odontology. Therefore, smile photographs constitute a reliable source of information with the potential to help solve certain cases of human identification.

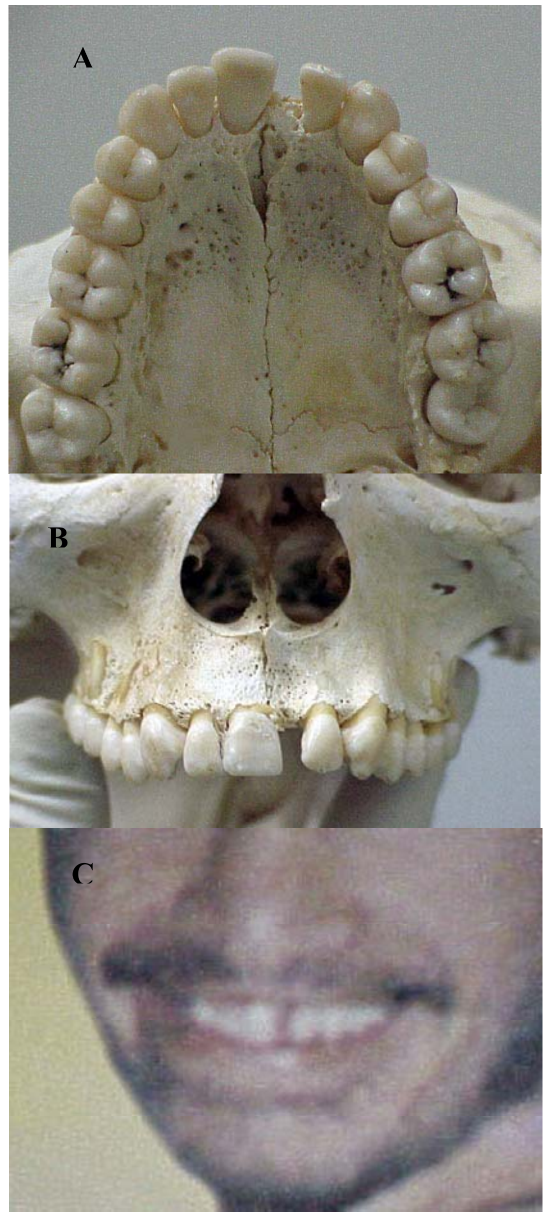

Fig.1: *Absence of 21 in the superior dental arch (A and B) and in the smile photograph (C).*

Fig.2: *Photographs of the victim in frontal view (A) and lateral right view (B).*

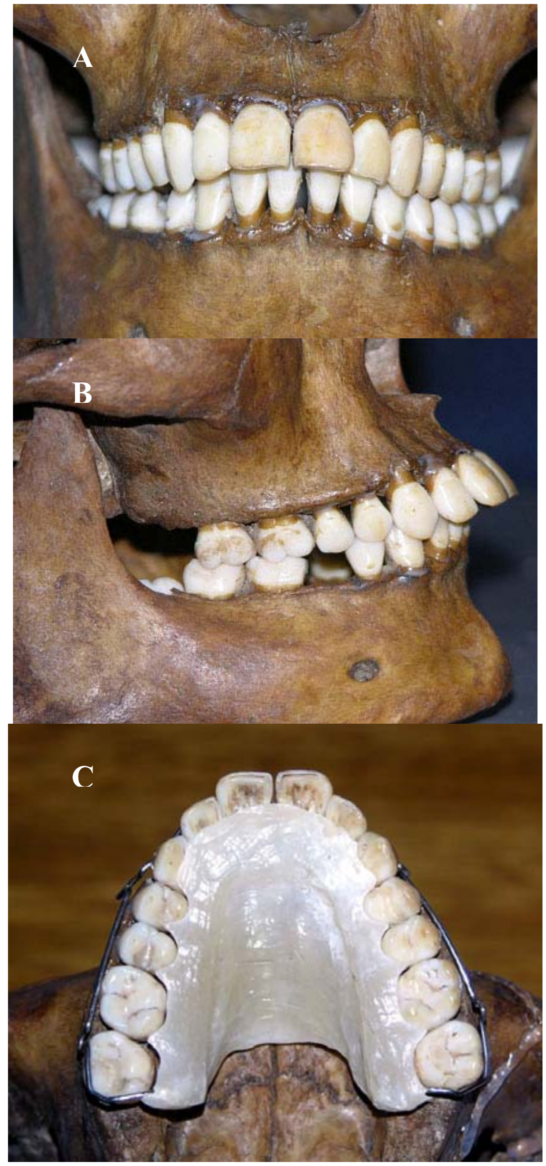

Fig.3: *– Characteristics of the occlusion and the superior incisors in frontal view (A), lateral right view (B) and orthodontic appliance adapted in the superior dental arch (C).*

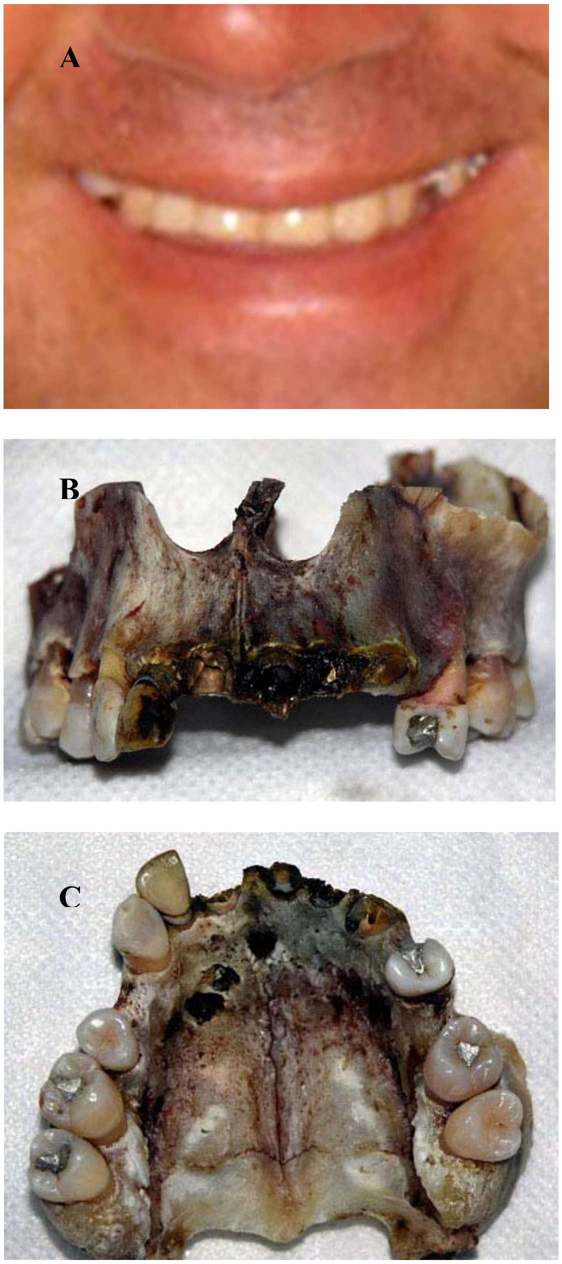

Fig.4: *Absence of upper left first pre-molar and presence of amalgam restoration in the mesial face of the element 25 in the smile photograph (A) and the upper dental arch in frontal view (B) and occlusal view (C).*

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REFERENCES

1. Oliveira RN, Daruge E, Galvão LCC, Tumang AJ. Collaboration of forensic odontology for identification post-mortem. Rev Bras Odontol 1998; 55(1): 117-22. Portuguese.

2. Silva RF *et al*. The importance of dental documentation in human identification: report of a case. Acta Odontol Venez 2005; 43(2): 67-74. Spanish.

3. Goodman NR, Himmelberger LK. Identifying skeletal remains found in a sewer. J Am Dent Assoc 2002; 133(11): 1508-13.

4. Miyajima F, Daruge E, Daruge Júnior E. The importance of dental science in human identification: a casework report. Arq Odontol 2001; 37(2): 33-42. Portuguese.

5. Silva RF *et al*. Confiability of forensic dental exam in human identification. ROBRAC 2004; 13(35): 46-50. Portuguese.

6. Silva RF *et al*. Dental radiographs: source of information for human identification. Odontologia Clín. Científ 2006; 5(3):239-42. Portuguese.

7. Nagai K, Sakoda S, Maeda H. Dental identification of decomposed victims in a case of multiple homicides by infection of succinylcholine. J Forensic Odontostomatol 1997; 15(2): 37-44.

8. Kirk NJ, Wood RE, Goldstein M. Skeletal identification using the frontal sinus region: a retrospective study of 39 cases. J Forensic Sci 2002; 47(2): 318-23.
9. Bilge Y *et al*. The identification of a dismembered human body: a multidisciplinary approach. Forensic Sci Int 2003; 137(2-3):141-46.

10. Marks MK, Bennett JL, Wilson OL. Digital video image capture in establishing positive identification. J Forensic Sci. 1997; 42(3): 492-95.

11. McKenna JJI. A qualitative and quantitative analysis of the anterior dentition visible in photographs and its application in forensic odontology. Hong Kong: University of Hong Kong, 1986: 131.

12. Silva RF *et al*. Genetics and molecular biology: a literature review of forensic dentistry applications. Braz J Oral Sci. 2007; 6(20): 1254-59.

13. Câmara CALP. Aesthetics in Orthodontics: Diagrams of Facial Aesthetic References (DFAR) and Diagrams of Dental Aesthetic References (DDAR). R Dental Press Ortodon Ortop Facial 2006;11(6): 130-56. Portuguese.

14. Machado AW, Oliveira DD, Leite EB, Lana AMQ. Film vs. digital photography: is the difference noticeable? R Dental Press Ortodon Ortop Facial 2005;10(4):115-23. Portuguese.

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FORENSIC NORMS OF FEMALE AND MALE LEBANESE ADULTS

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ABSTRACT

Patients born to Lebanese parents and grandparents, visiting two private practice orthodontic clinics, with normal occlusion and no need for any kind of orthodontic treatment during a six month period and satisfying inclusion criteria, were asked permission to include their lateral cephalometric radiographs in this study. Sixty three individuals met the inclusion criteria. Sixteen cephalometric measurements were taken (seven linear and nine angular) were analyzed on each radiograph. Measurements were compared between genders using student's t-test.

The study population included 31 females and 32 males with a mean (±SD) of 21.6 (±4.0) and 21.3 (±3.9) years for males and females respectively. Men had significantly larger skeletal linear measurements: the mandibular base menton to gonion (Me-Go) (p = 0.027), the total mandibular length of condylon to gnathion (Co-Gn) (p = 0.009) and significantly larger angular measurements: sella to nasion to subspinal point (S-N-SS) (p = 0.006), and sella to nasion to supramental point (S-N-Spm) (p = 0.009).

The results of this study demonstrated that male skeletal linear and angular measurements are significantly larger in

Lebanese adult males compared to Lebanese adult females.
(J Forensic Odontolstomatol 2008;27:1:18-23

Keywords: forensic norms, cephalometric analysis, gender, linear measurement, angular measurement

INTRODUCTION

Forensic norms have been set up for many ethnic and racial groups in many studies; differences among races and ethnic groups have been proven, and standard norms have been developed.[1,2] These studies have supported the assumption that normal measures for one attempt have been made to identify the differences in facial features of various ethnic groups including Africans, African-Americans,[3,4] Brazilians,[5] Japanese,[6] Puerto Ricans,[7] Saudi Arabians[2], Turkish[8,9], Hungarians[10] and Russians.[11] Standard norms for each ethnic group are critical for forensic medicine.[12]

Information on cephalometric norms for a population has tremendous value in forensic dentistry. Cephalometric standards allow identification of race and gender of victims using simple measurements.[10,12-14] Craniofacial measurements and dentofacial models of different ethnic groups and their cephalometric norms are useful in planning and estimating impact of orthodontic treatment on hard and soft tissue.[13,15-17]

Since no forensic norms are yet available for Lebanese population, the purpose of this study is to establish forensic norms to use for forensic purposes using 16 cephalometric measures obtained on a lateral cephalometric radiography. In addition, identification of gender differences was also investigated.

MATERIALS AND METHODS

Inclusion criteria

Sixty-three patients visiting two private practice orthodontic clinics for routine checkups, who had had a normal occlusion with no need at all for any orthodontic treatment during a six month period met the study criteria, and were asked for permission to include their cephalometric radiographs in this study:

1. Aged 17 to 26.
2. Lebanese citizens with both parents and both grand parents on both sides Lebanese as well.
3. Class I molar and/or canine relationship (normal occlusion).
4. Normal height and weight for age with no significant medical history; normal growth pattern.
5. No history of trauma.

6. No previous orthodontic or prosthodontic treatment and no actual need for such kind of treatment.
7. No previous maxillofacial or plastic surgery.
8. Good facial symmetry determined clinically.
9. All teeth present except third molars.
10. No significant medical history.

Individuals who were noted not to satisfy any of the ten criteria above after taking radiographs, such as need of any kind of therapeutic intervention to adjust their occlusion or orthodontic profile, missing teeth or evidence of trauma or surgery, were excluded.

Lateral cephalograms were obtained in a standard position with the teeth in centric position and with lips relaxed for all 63 individuals using the same radiographs apparatus (Planmeca, Helsinki, Finland) and standardized mandibular orientation and exposure parameters. Sixteen measurements (seven linear and nine angular) were analyzed on each radiograph. Arithmetic mean and standard deviation were calculated for each measurement.

The same researcher performed the tracing of the cephalometric radiograph of each subject; one researcher took all measurements, and two other researchers reviewed them.

Cephalometric variables

A. Landmarks

The landmarks used for cephalometric analysis were defined based on Fricker guidelines (Fig. 1).[1,18-20] In addition Sella (S), S', which is the projection of S on the plane of Frankfort was likewise used. As well, Co' which is the projection of Condylon (Co) on the plane of Frankfort as used by Russians was similarly used.[11]

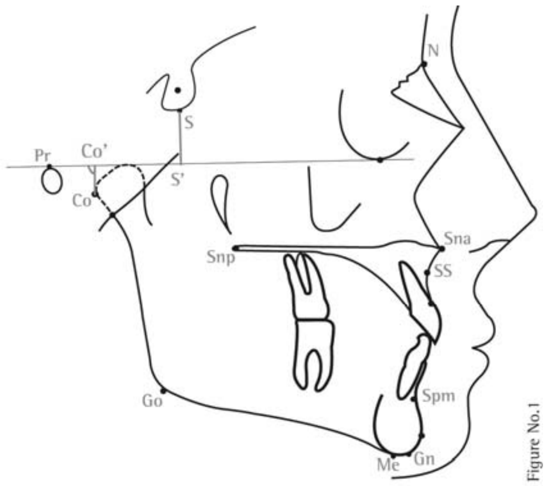

Fig. 1:
Landmarks used for cephalometric analysis: N, S, Me, Gn, Go, SS, Spm, Sna, Snp, Co, Co', Pr, S'.

B. Planes

The used planes as described by Fricker namely palatal plane or bispinal (Ps), mandibular plane (Pm), mandibular ramus plane (Pr), axis of the maxillary incisor (Pis) and axis of the mandibular incisor (Pii).[18] (Fig. 2)

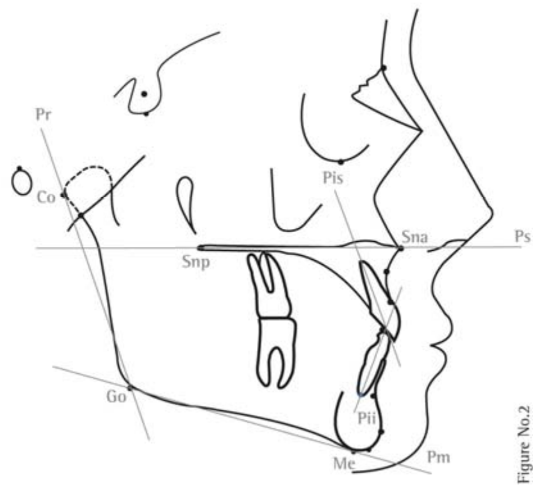

Fig. 2:
Planes used for cephalometric analysis:
Ps, Pm, Pr, Pis, Pii.

C. Linear measurements

The linear measurements calculated by millimeters are the following.[18] (Fig. 3)

1. N-S: Anterior cranial length: describes the length of the anterior cranial base.

2. Sna-Snp: Palatal plane length: indicates contribution of the maxilla to horizontal dimension. extend
3. Me-Go: menton-gonion: The extent of the mandibular base (Sassouni).
4. N-Sna: Midfacial anterior height: vertical dimension between nasion to anterior nasal spine.
5. Sna-Me: Lower anterior face height: vertical dimension between anterior nasal spine to menton.
6. Co-Gn: Describing the total mandibular length: condylon to gnathion.
7. S'-Co': Dimension measured on Frankfort horizontal plane between the projection of sella and condylon.

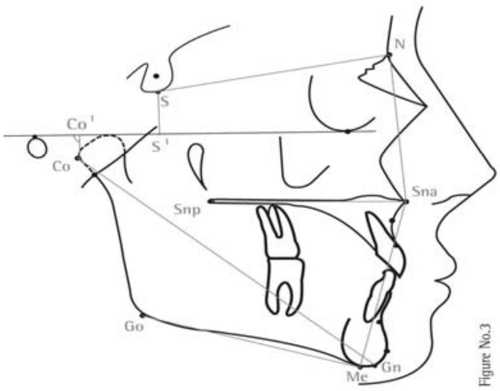

Fig. 3:
Linear measurements calculated by mm are seven: N-S, Sna-Snp, Me-Go, N-Sna, Sna-Me, Co-Gn, S'-Co'.

D. Angular measurements

Angles calculated in degrees, are the following:[14,18,21] (Fig. 4)

1. S-N-SS: (SNA) describes the horizontal position of the maxilla to the cranium (Steiner).
2. S-N-Spm: (SNB) indicates the position of the mandible to the cranial base.
3. ANB: Magnitude of the horizontal skeletal jaw discrepancy between the maxilla and the mandible, obtained by subtracting SNB from SNA.
4. Pm/Pr: Gonial angle, the angle between the mandibular plane and the mandibular ramus plane.
5. Pis/Ps: The maxillary central incisor to the maxillary plane; U1 to the palatal plane.
6. Pii/Pm: The mandibular central incisor to the mandibular plane; L1 to the mandibular plane.
7. Pis/Pii: The interincisial angle; U1 to L1.
8. Ps/Pm: The palatal plane to the mandibular plane.
9. N-Sna-Me: The facial angle-angle convexity.

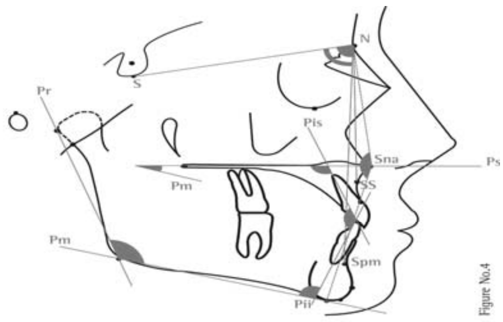

Fig. 4:
The nine angles calculated in degrees:
S-N-SS; S-N-Spm; ANB; Pm/Pr; Pis/Ps; Pii/Pm; Pis/Pii; Ps/Pm; N-Sna-Me.

Statistical Analysis

Arithmetic means and standard deviations (±SD) were calculated for age, linear and angular measurements for both males and females. As all our variables were numerical continuous, so student t test was performed to compare these variables among males and females. Significance was set at a p value of 0.05.

RESULTS

Gender comparison

Sixty-three participants entered into final data analysis; 31 females and 32 males. The average age of the group was 21.6 (±4.0) years for males, and 21.3 (±3.9) years for females.

Table 1 shows the results of all the measured variables, and it compares the average values of men and women. Men had significantly larger measurements of two linear and two angular skeletal parameters: Me-Go, Go-Gn, S-N-SS and S-N-Spm ($p < 0.05$). However, all other parameter differences were non-significant between the two genders.

The significant skeletal differences were seen in the antero-posterior position of the maxilla and the mandible to the cranial base: SNA (S-N-SS), SNB (S-N-Spm) ($p = 0.006$ & 0.009 respectively), the total mandibular length (Co-Gn) ($p = 0.009$) and the extent of the mandibular base (Me-Go) ($p = 0.027$).

In dental relationships and dental measurements, no statistically significant sexual dimorphism was found. The mean (±SD) of Pis/Ps angles among males was 111.87º (±6.57º) whereas 111.48º (±8.69º) among females. Thus, the mean value was greater than 107º. The measurements of this angle are relative to the norms of Downs and Tweed.

Furthermore, the Lebanese norms were 94.13º (±16.84º) for men and 96.42º (±6.58º) for women for the Pii/Pm showing greater norms than those of Tweed 90º and Downs 91.4º (±3.8º).

DISCUSSION

To our knowledge this is the first descriptive study about male and female Lebanese adults establishing forensic norms. The results of this study on a sample of adult Lebanese population indicated that some linear and angular measurements are significantly different between male and female adult Lebanese.

Two linear values; Me-Go appraising the length of the mandibular corpus, Co-Gn evaluating the total mandibular length and two angular values S-N-SS and S-N-Spm demonstrated a significant difference between both Lebanese adult genders. Our population presented with normal occlusion and orthodontic profiles to the two orthodontic clinics where a check-up was the main purpose of their visits,and neither occlusal nor orthodontic treatment was needed or applied.

In accordance to the craniofacial structure of Anatolian Turkish adults.[8] Caucasoid young adults [10] and two adolescent populations from Iowa and Northern Mexico, the Lebanese men have significantly larger measurements than Lebanese women.[16]

As the mean values for measurements of one racial group could not be considered normal for others, the rationale to conduct this study and obtain these norms was crucial. Numerous studies have shown that differences between racial groups could exist.[2,3,6,8,22] Lebanese are currently considered a subgroup of Caucasians, descendants of the Phoenicians/Canaanites. However, in the modern biological model, variations occur and are not perceived as unnatural within the same race or/and ethnic group. In reality, attempts to achieve perfection for all individuals are seen as unnatural; therefore, each different racial subgroup would best be treated according to its individual characteristics in order to achieve proper forensic norms. The measurements of Pis/Ps for men and women were relative to the norms of Downs and Tweed. However, the Lebanese norms for the Pii/Pm were greater than the norms of Tweed and Downs.

It is notable that the Russian norms apply different landmarks than other populations' norms by using the projection of the sella point (S) on the Frankfort horizontal plane (S'), instead of the sella point itself (Fig. 1), as a landmark. The same concept is also applied to the condylon (Co) landmark, using its projection on the Frankfort horizontal plane (Co') (Fig. 1). We liked to use these two reference points with the purpose to conduct a further study in the near future comparing the Russian norms and the Lebanese norms, including a larger sample size in order to assess if there is any difference among these two sub-groups of the Caucasian race, as they are the only using these two points in their norms.

A major limitation of this study was the sample size due to limited financial resources. Further studies with larger sample size are recommended.

In conclusion, our results are useful for the Lebanese adults among both genders in forensic dentistry for identification purposes. The present study also supports the view that males have larger standards of linear and angular facial measurements, previously established among various racial and ethnic groups.

Table 1: *Comparison of male and female cephalometric measurements of a sample of Lebanese adults. (N=63).*

	Measurement unit	Male		Female		T test	P-value
		Mean	SD	Mean	SD		
AGE	Years	21.60	4.03	21.32	3.94	-0.270	0.788
N-S	mm	74.00	6.32	72.88	4.47	-0.816	0.418
Sna Snp	mm	61.01	4.02	60.26	3.82	-0.760	0.450
Me-Go	mm	75.68	5.41	72.80	4.70	-2.260	0.027
N-Sna	mm	53.94	3.90	53.30	5.50	-0.537	0.594
Sna-Me	mm	71.10	6.71	69.25	6.33	-1.120	0.267
Co-Gn	mm	118.70	5.98	114.74	5.73	-2.685	0.009
S'-Co'	mm	18.03	4.50	17.00	3.75	-0.995	0.324
S-N-SS	deg	79.50	4.18	76.71	3.63	-2.825	0.006
S-N-Spm	deg	75.44	4.09	72.74	3.74	-2.716	0.009
ANB	deg	4.03	2.61	3.55	2.83	-0.672	0.504
Pm-Pr	deg	119.66	7.16	119.26	10.64	-0.161	0.873
Pis-Ps	deg	111.87	6.57	111.48	8.69	-0.201	0.841
Pii-Pm	deg	94.13	16.84	96.42	6.58	0.718	0.477
Pis-Pii	deg	129.20	7.62	127.10	10.24	-0.916	0.363
Ps-Pm	deg	23.87	7.94	25.06	5.61	0.711	0.480
N-Sna-Me	deg	160.20	6.63	159.19	7.57	-0.544	0.588

mm: millimeters; deg: degrees; $p < 0.05$ was considered significant.

REFERENCES

1. Athanasios, E. Athanasiou. Orthodontic Cephalometry. 1st edn. London. Mosby-Wolfe, 1995:42-44.

2. Shalhoub SY, Sarhan OA, Shaikh HS. Adult cephalometric norms for Saudi Arabians with a comparison of values for Saudi and North American Caucasians. Br J Orthod 1987;14:273-9.

3. Drummond RA. A determination of cephalometric norms for the Negro race. Am J Orthod 1968;54:670-82.

4. Fonseca RJ, Klein WD. A cephalometric evaluation of American Negro women. Am J Orthod 1978;73:152-60.

5. Cerci V, Martins JE, de Oliveira MA. Cephalometric standards for white Brazilians. Int J Adult Orthodon Orthognath Surg 1993;8:287-92.

6. Miyajima K, McNamara JA Jr, Kimura T, Murata S, Iizuka T. Craniofacial structure of Japanese and European-American adults with normal occlusions and well-balanced faces. Am J Orthod Dentofacial Orthop 1996;110:431-8.

7. Evanko AM, Freeman K, Cisneros GJ. Mesh diagram analysis: developing a norm for Puerto Rican Americans Angle Orthod 1997;67:381-8.

8. Basciftci FA, Uysal T, Buyukerkmen A. Craniofacial structure of Anatolian Turkish adults with normal occlusions and well-balanced faces. Am J Orthod Dentofacial Orthop 2004;125:366-72.

9. Hwang HS, Kim WS, McNamara JA Jr. Ethnic differences in the soft tissue profile of Korean and European-American adults with normal occlusions and well-balanced faces. Angle Orthod 2002;72:72-80.

10. Budai M, Farkas LG, Tompson B, Katic M, Forrest CR. Relation between anthropometric and cephalometric measurements and proportions of the face of healthy young white adult men and women. J Craniofac Surg 2003;14:154-61.

11. Sherbakov A C, Lapookova N.B. Anthropometric and cephalometric analysis. Tver-Russia 1997:5-27.

12. Noosintchouk R.M. Manuel d'odontologie medico-legale . Masson 1991:83-102.

13. Baydas B, Yavuz I, Dagsuyu IM, Bolukbasi B, Ceylan I. An investigation of maxillary and mandibular morphology in different overjet groups. Aust Orthod J 2004;20:11-8.

14. Valente RO, de Oliverira MG. [Normative values and sexual dimorphism in aesthetically pleasant profiles, through cephalometric computerized analysis (Ricketts and McNamara)]. Pesqui Odontol Bras 2003;17:29-34.

15. Bishara SE, Jakobsen JR, Hession TJ, Treder JE. Soft tissue profile changes from 5 to 45 years of age. Am J Orthod Dentofacial Orthop 1998;114:698-706.

16. Bishara SE, Fernandez AG. Cephalometric comparisons of the dentofacial relationships of two adolescent populations from Iowa and northern Mexico. Am J Orthod 1985;88:314-22.

17. Jean-Paul Loreille. Cephalometric and Orthodontic. Editions S.N.P.M.D Paris:40-55.

18. John P Fricker. Orthodontics and dentofacial orthopaedics. Tidbinbilla Australia 1998;6:109-54.

19. Graber TM, Rakosi T, Petrovic AC. Dentofacial orthopedics with functional appliances. 2nd Edition. Missouri, USA. C.V. Mosby Publisher. 1997,6,pp 107-24.

20. William R. Proffit, Henry W. Fields. Contemporary Orthodontics. 3rd Edition. North Carolina, Chapel Hill, USA. Mosby Publisher. 2000,pp 172-4.

21. Bishara SE. Textbook of Orthodontics. Iowa City, USA. Saunders Publisher. 2001,10,pp 113-125.

22. Al-Jasser NM. Cephalometric evaluation for Saudi population using the Downs and Steiner analysis. J Contemp Dent Pract 2005;6:52-63.

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TECHNICAL NOTE

AGE ESTIMATION FROM MANDIBLE BY LATERAL CEPHALOGRAM: A PRELIMINARY STUDY

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ABSTRACT

Age estimation is an important aspect of forensic investigation and is considered as one of the "Big Four" of Forensic Anthropology. One hundred and twenty (120) cephalograms of individuals aged 7-20 years were examined with reference to mandibular body length (distance between Gonion and Gnathion) mandibular length (distance between Co and Gn) and mandibular height (distance between Co and Go). An attempt has been made to assess the utility and dependability of these three linear parameters for age estimation. The mandibular body length, ramus height and mandibular length were increased by 2.23, 3.26, 4.26 mm/years respectively. There are no significant differences in mandibular linear growth between the two sexes though the female mandible has a higher growth rate compared to males. These parameters might prove to be of importance in age determination for medico-legal purposes.
(J Forensic Odontostomatol 2008;27:1:24-28)

Keywords: forensic anthropology, forensic odontology, age estimation, mandible, lateral cephalogram

INTRODUCTION

Research into facial growth and development is essential in orthodontics as well as in forensic medicine for diagnosis and identification. Among several maturational indicators, skeletal development appears to be quite a simple and accurate one. Skeletal age can be determined by radiographs, relating the appearance and development of certain bones with given maturational stages.[1,2] Various studies have been conducted on the estimation of age from teeth and facial dimensions and their possible use in the forensic case work.[3-29] Considerable attention has been paid to mandibular growth because it has been reported that this bone enlarges the most during adolescence.[30,31] It has also been observed that the mandible grows in a posterior-superior direction resulting in at anterior inferior displacement.[32] It has been demonstrated that mandibular sagittal growth is due to posterior deposition and anterior resorption in the ramus. In the mandible, growth spurts may occur, but not in a uniform amount and duration.[33] The aim of the present study was to determine mandibular growth in different stages of adolescence in North India for age estimation in forensic science.

MATERIALS AND METHODS

The study was conducted on randomized 120 (57 males and 63 females) lateral cephalograms; aged 7-20 years of age from the Department of Orthodontics, Government Dental College, Pt. Bhagwat Dayal Sharma, Post Graduate Institute of Medical Sciences, Rohtak, Haryana, India. The criteria for sample selection demanded an ANB angle between 0 and 4 (the angle between the most anterior point of maxilla, A, and the most anterior point of mandible, B, to nasion, N, the deepest point of the nasal root in the mid-sagittal plane). In this manner, subjects with skeletal class II or III were excluded. Furthermore, patients with missing teeth or with syndromes, cleft lip or palate, or other craniofacial pathology, were also excluded. Patients were asked whether they had used any medication that may have affected their growth or development. Also included were patients who had undergone minor orthodontic treatment that did not seem to influence linear mandibular growth and development.[34] Each cephalogram was computerized, traced and cephalometric points were measured. The study used the following cephalometric landmarks; point A (the most posterior point on the curve between anterior nasal spine and superior prosthion), point B (the most posterior point of the bony curvature of the mandible below infradentale and above pogonion), nasion (N), condylon (Co), Gonion (Go) and gnathion (Gn). Three linear measurements for the determination of mandibular growth were; mandibular body length (distance between Go and Gn) mandibular length (distance between Co and Gn) and mandibular height (distance between Co and Go) (Fig. 1). These data were analyzed by using Statistical Package for Social Sciences (SPSS), Version 7.0.

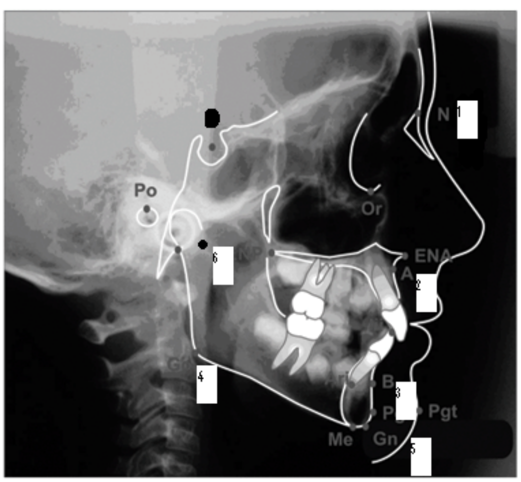

Figure 1. Cephalometric points

Fig.1: *Parameters of cephologrəms.*

RESULTS AND DISCUSSION

Table 1 presents the mandibular growth rate (Mean ± SD) between skeletal class I and class II in both the sexes. In class I and class II skeletal as well as in gender, no significant difference in growth rates (Table I) is found, though growth rate is higher in female as compared to male except in mandibular length.

Table I shows the mandibular annual growth rate in adolescence phase was 2.35 mm of the mandibular body length, 3.66 mm for the ramus height, and 3.95 mm for the mandibular length. While the mandibular length annual growth rate was less (1.78 mm/y) as compared to Japanese population studies by Sato *et al.*[35] It has been recently reported that ramus growth rate was 2.06 mm/y in males and 1.42 mm/y in females less as compared to present study.[34] There are no significant differences in mandibular linear growth between two sexes. The age can be determined from the cephalograms by above equations (equation 1,2,3). This method of age determination can be applied up to 20 years of age. Hence, these linear parameters can act as growth spurt. The increase in linear parameters due to mandibular growth i.e. mandibular jaw grows in a posterior superior direction resulting in at anterior inferior displacement.[31-33]

Table 1: *Mandibular growth rates (mm/year) between skeletal class I and class II in both genders.*

Parameters	Skeletal types	Sex	Growth rate (in mm/years) mean ± SD
Mandibular ramus height	Class I	M	2.71 ± 0.13
		F	3.08 ± 0.12
	Class II	M	3.98 ± 0.23
		F	3.99 ± 0.21
Mandibular body length	Class I	M	2.42 ± 0.14
		F	2.82 ± 0.13
	Class II	M	1.97 ± 0.14

		F	2.01 ± 0.13
Mandibular length	Class I	M	3.42 ± 0.17
		F	3.31 ± 0.12
	Class II	M	4.72 ± 0.13
		F	4.32 ± 0.15

p<0.05 at all levels.

$$\text{Age (in years)} = \frac{\text{Calculated mandibular body length by cephalometric}}{2.35} \quad (1)$$

$$= \frac{\text{Calculated ramus height from cephalograms}}{3.66} \quad (2)$$

$$= \frac{\text{Calculated mandibular length from cephalograms}}{3.95} \quad (3)$$

All above formulae can be applied up to 20 years of age.

REFERENCES

1. Scammon RE. The first seriatim study of human growth. Am J Phys Anthrop 1927;10:329-36.

2. Hunter CJ. The correlation of facial growth with body height and skeletal maturation at adolescence. Angle Orthod 1966;36:44-54.

3. Rai B, Anand SC. Age Estimation in Children from dental Radiograph: A Regression Equation. Internet J Biol Anthropol; 2008, in press.

4. Rai B, Dhattarwal SK, Anand SC, Kharb S. Modifications in Gustafson's method: Age estimation. Medico-legal Update 2007;7:7-9.

5. Claramunt R, Sevilla T, Lupo V, Cuesta A, Millan J, Vilchez J, Palau F, Espinos C. The p.R1109X mutation in SH3TC2 gene is predominant in Spanish Gypsies with Charcot-Marie-Tooth disease type 4. Clin Genet 2007;71:343-9.

6. Martin-de Las Heras S, Garcia-Fortea P, Ortega A, Zodocovich S, Valenzuela A. Third molar development according to chronological age in populations from Spanish and Magrebian origin. Forensic Sci Int 2007, doi:10.1016/j.forsciint.2007. 03.009, in press.

7. Yun JI, Lee JY, Chung JW, Kho HS, Kim YK. Age estimation of Korean adults by occlusal tooth wear. J Forensic Sci. 2007; 52(3): 678-83.

8. Olze A, van Niekerk P, Ishikawa T, Zhu BL, Schulz R, Maeda H, Schmeling A. Comparative study on the effect of ethnicity on wisdom tooth eruption. Int J Legal Med. 2007, 10.1007/s00414-007-0171-9, in press.

9. Meinl A, Tangl S, Pernicka E, Fenes C, Watzek G. On the applicability of secondary dentin formation to radiological age estimation in young adults. J Forensic Sci. 2007;52:438-41.

10. Blankenship JA, Mincer HH, Anderson KM, Woods MA, Burton EL. Third molar development in the estimation of chronologic age in american blacks as compared with whites. J Forensic Sci. 2007;52:428-33.

11. Rai B, Anand SC, Bharwaj DN, Dhattrwal. Coronal Displacement of Cementum as an Age Determinant. WJMS 2006;1:93-94.

12. Yekkala R, Meers C, Hoogmartens J, Lambrichts I, Willems G, Van Schepdel A. An improved sample preparation for an LC method used in the age estimation based on aspartic acid racemization from human dentin. J Sep Sci. 2007;30:118-21.

13. Sciulli PW. Relative dental maturity and associated skeletal maturity in prehistoric native Americans of the Ohio valley area. Am J Phys Anthropol 2007; 132:545-57.

14. Cameriere R, Ferrante L, Belcastro MG, Bonfiglioli B, Rastelli E, Cingolani M.

Age estimation by pulp/tooth ratio in canines by peri-apical X-rays. J Forensic Sci 2007;52:166-70.

15. Azrak B, Victor A, Willershausen B, Pistorius A, Horr C, Gleissner C. Usefulness of combining clinical and radiological dental findings for a more accurate noninvasive age estimation. J Forensic Sci 2007;52:146-50.

16. Cardoso HFV. Accuracy of developing tooth length as an estimate of age in human skeletal remains: The deciduous dentition. Forensic Sci Int 2006, doi:10.1016/j.forsciint.2006. 11.006, in press.

17. Rai B. Age Determination from dental root. Internet J Biol Anthropol 2008, in press.

18. Offele D, Harbeck M, Dobberstein RC, von Wurmb-Schwark N, Ritz-Timme S. Soft tissue removal by maceration and feeding of Dermestes sp.: impact on morphological and biomolecular analyses of dental tissues in forensic medicine. Int J Legal Med. 2006, 10.1007/s00414-006-0116-8.

19. Brkic H, Milicevic M, Petrovecki M. Age estimation methods using anthropological parameters on human teeth. Forensic Sci Int 2006;162:13-16.

20. Cameriere R, Brogi G, Ferrante L, Mirtella D, Vultaggio C, Cingolani M, Fornaciari G. Reliability in age determination by pulp/tooth ratio in upper canines in skeletal remains. J Forensic Sci 2006;51:861-4.

21. Schmeling A, Geserick G, Reisinger W, Olze A. Age estimation. Forensic Sci Int 2007;165:178-81.

22. Koubik AC, Franca BH, Ribas Mde O, de Araujo MR, Mattioli TM, de Lima AA. Comparative study of chronological, bone, and dental age in Fanconi's anemia. J Pediatr Hematol Oncol 2006;28:260-2.

23. Raitz R, Fenyo-Pereira M, Hayashi AS, Melani R. Dento-maxillo-facial radiology as an aid to human identification. J Forensic Odontostomatol 2005;23:55-9.

24. Fridell S, Ahlqvist J. The use of dental radiographs for identification of children with unrestored dentitions. J Forensic Odontostomatol 2006;24:42-6.

25. Olze A, Geserick G, Schmeling A. Age estimation of unidentified corpses by measurement of root translucency. J Forensic Odontostomatol 2004;22:28-33.

26. Chaillet N, Willems G, Demirjian A. Dental maturity in Belgian children using Demirjian's method and polynomial functions: new standard curves for forensic and clinical use. J Forensic Odontostomatol 2004;22:18-27.

27. Ball J. A critique of age estimation using attrition as the sole indicator. J Forensic Odontostomatol 2002;20:38-42.

28. Amariti ML, Restori M, De Ferrari F, Paganelli C, Faglia R, Legnani G. A histological procedure to determine dental age. J Forensic Odontostomatol 2000; 18:1-5.

29. Krishan K, Vashisht RN, Vij K. Teeth in personal identification. Medico-legal Update 1997;2:9-11.

30. Bishara SE, Jamison JE, Peterson LC, Dekock WH. Longitudinal changes in standing height and mandibular parameters between the ages of 8 and 17 years. Am J Orthod 1981;80:115-35.

31. Fishman LS. A longitudinal cephalometric study of the normal cranio-facial profile, utilizing a proportional analysis of skeletal, soft tissues and dental structures. Int Dental J 1979;19:351-79.

32. Moyers RE. Ortodontia. Rio de Janeiro, RJ: Guanabara Kozgan; 1999:8-139.

33. Moore RN, Moyer BA, DuBois LM. Skeletal maturation and cranio-facial growth. Am J Orthod Dento Facial Orthop 1990;97:33-40.

34. Huang G.J. Functional appliances and long- term effects on mandibular growth, Am J Orthod Dentofacial Orthop 2005;128:271-271

35. Sato K, Mito T, Mitani H. An accurate method of predicting mandibular growth potential based on bone maturity. Am J Orthod Dentofacial Orthop 2001;120: 286-290.

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