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Forensic Anthropology Population Data

Facial soft tissue thickness in the Brazilian population: New reference data and anatomical landmarks

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ABSTRACT

Facial soft tissue thickness measurement can be useful among several medico-legal techniques that aim to establish the identity of skeletal remains. This study examined the soft tissue thickness that covered the faces of autopsied cadavers sent to the Medico-Legal Institute of Guarulhos from September 2010 to September 2011. Forty-nine anatomical facial landmarks were measured in cadavers less than 24 h after death; these data were analysed using two-tailed *t*-tests. This project was approved by an ethics committee. One hundred cadavers were studied (74 males and 26 females). A majority of these individuals had died between 41 and 60 years old. Of the 49 anatomical landmarks, only five differed between the sexes (i.e., *p*-value less than 0.05): upper lip margin ($p = 0.006$), superior labial sulcus ($p = 0.006$), stomion ($p = 0.001$), right lateral orbit ($p = 0.008$), and left cheilion ($p = 0.009$). The inclusion of additional anatomical landmarks allowed us to establish more precise facial thickness parameters that have the potential to be applied to cadaver facial approximations in Brazil; furthermore, some anatomic landmarks presented a higher discriminant power with regard to sex.

1. Introduction

When a skeleton cannot be identified using standard medico-legal assessments, forensic facial approximation can be employed [1]. This methodology reconstructs a face with the aim of reaching subsequent identification using forensic techniques [2]. Establishing parameters that represent the thickness of the soft tissues that cover certain craniometric points is necessary to reconstruct a face.

Thus, this technique has great value to forensic anthropology because it had the potential to add information to the identification of the deceased using *ante* and *post-mortem* examinations. Some studies have demonstrated the limitations of anatomical landmarks that make performing approximations difficult. When the American method of facial approximation (using tissue depth markers) was used in order to build emaciated, normal and obese faces, Starbuck and Ward [3] observed that subjects tended to perceive the same person approximations as being from different individuals. Wilkinson [2] observed that a combination of art and science is needed to perform complete approximations.

Krogman [4] suggested a protocol for facial approximation. To test the accuracy of Krogman's method, Snow et al. [5] conducted a study of four approximations; it was observed a high rate of hits occurred for the male cadaver (67%); however, the success rate was only 26% for the female cadaver. In fact, some studies have shown that the hit rate for females is always lower compared with males [6,7]. A reason for this discrepancy could be that more males die due to violent causes [8], and their bodies are sent to death verification services, which is where the studies that measure facial tissue thickness are traditionally performed.

Stephan and Simpson performed a review of the published data with regard the facial soft tissue depths in craniofacial identification [9], and they highlight that modern data and specific to countries must be collected before using other samples (http://www.craniofacialidentification.com).

There is a reference table available in Brazil that is composed of 10 midline and 11 bilateral anatomical points; however, this table was created using a sample of mostly elderly individuals [7]. Our hypothesis is that soft tissue depths behave similarly than skin colour in the Brazilian population, which experiences a high level of admixture; so, the parameters established in other countries may not apply to Brazil; even in other countries, this issue has

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shown to be based on subjective interpretations (physical appearance or place of study) [9]. Molecular markers used to detect colour and genetic ancestry in Brazilians found that the African ancestry index values were intermediate between European and Africans [10]. The present study tests traditional and novel landmarks of facial tissue thickness in adult cadavers from Brazil.

2. Materials and methods

One hundred cadavers were measured at the Medico-Legal Institute of Guarulhos. The materials used in this study included fine steel needles, markers with silicone stops, callipers, and examination forms. One researcher, who had previous experience with this type of examination and facial approximations, performed all of the examinations.

Only cadavers without traumas or deformities affecting the facial tissues were measured. Cadavers were identified by numbers and classified based on sex, age, and time since death.

The selected craniometric points were localised by palpation. The needle was introduced perpendicular to the skin until it encountered bone resistance in the local tissue at which point the stop was placed to rest on the soft tissue. The measurements were performed using callipers (Electronic digital calliper Stainless Hardened, 0–150 mm with 0.03 accuracy, 0.01 resolution) after the needles were removed and they were located by palpation using soft tissue landmarks.

Thirteen midline and 18 bilateral points were measured and are described (Table 1 and Fig. 1).

A difficulty concerned the number of anatomical landmarks found in the literature, which has ranged from 10 to 52 [1,6,7,11–16]. The anatomical landmarks measured in the present study were based on those described by Rhine and Campbell [11] as well as Tedeschi-Oliveira et al. [7]. Thirty-one landmarks were measured, and the names of 11 areas were changed to translate the table into English. The midline landmarks whose names were changed supradentale, which corresponds to the upper lip margin; infradentale, which corresponds to the lower lip margin; and menton, which corresponds to beneath the chin.

To complement the aforementioned studies, the present study included some points that are important for forensic artists and are found in George's Atlas of Facial Geometry [17]. The points added on the midline were the supratip break, superior labial sulcus, and stomion, and they have been already used in other studies [9]. The points added on the bilateral were ectocanthion, endocanthion, alare, infra-canine, supra-canine, cheilion, and the mid-ramus of the mandible. These points were added because we felt they were needed to perform the practical aspects of facial approximation, increase the number of reference landmarks, and possibly could be useful to perform more accurate facial approximations.

One examiner performed the measurements twice in a 2-h period, and we could calculate intra-observer concordance. Furthermore, her previous experience in performing the measures of the other Brazilian study [7] was useful in order to reach accurate measures. Of the 49 measurements recorded, only three exhibited significant differences: the frontal eminence as well as the right and left inferior malar. The inferior malar landmark differences might have occurred because this point is located in an area of fat deposition and varies greatly as a function of nutritional status. Therefore, this variable was not considered in the present study due to this variance. A Portuguese study [6] also related the inferior malar to nutritional status.

Descriptive statistics (means and differences) described the results. Skewness and kurtosis tests were used in order to verify the presence of normally distributed in all data. Intraclass correlation was used measure the differences in the examinations taken by the same observer and differences in male and female measures were described. All analyses were performed using the software STATA 10.0, and the significance threshold was 0.05.

Before starting the investigation, the project was approved by the local Ethics Committee.

3. Results

One examiner measured 21 cadavers twice. Most anatomical landmarks did not differ between measurements ($p > 0.05$; Table 2). The landmarks that exhibited significant differences included the right frontal eminence ($p = 0.001$) as well as the right ($p = 0.0019$) and left ($p = 0.012$) inferior malar (Table 2).

Of the 100 cadavers, 74 were male, and 26 were female (Table 3). Only five of the 49 landmarks measured exhibited between-sex differences associated with p-values less than 0.05; in other words, the following measurements differed between males

Table 1
Description of the anatomic landmarks.

Anatomical landmarks	Description
Midline landmarks	
1. Supraglabella	The most anterior point of the forehead, above the glabella in the mid-sagittal plane
2. Glabella	The most prominent point between the supra orbital ridges in the mid-sagittal plane
3. Nasion	Midpoint of the frontonasal suture
4. Rhinion	The midpoint of the internasal suture on its most inferior and anterior portion
5. Supratip break[a]	The slight indentation near the nasal tip formed by the alar cartilage overlapping the septal and lateral nasal cartilages
6. Mid-philtrum	The lowest point of the interior margin of the pyriform aperture at the base of the nasal spine projected onto the sagittal plane
7. Upper lip margin	Midline on the upper lip
8. Superior labial sulcus[a]	The point of maximum indentation of the upper lip
9. Stomion[a]	The intersection of the mid-sagittal plane with the labial fissure
10. Lower lip margin	Midline on the lower lip
11. Chin-lip fold	The point located at the depression of the mandibular midline between the teeth and the mental eminence
12. Pogonion	The most prominent point in the midline of the mental protuberance
13. Beneath chin	The most downward projecting point of the mandibular anterior margin on the mid-sagittal plane
Bilateral landmarks	
14. Frontal eminence	The most salient point of the frontal bone
15. Supraorbital	Centre upper part of the margin of the orbit
16. Suborbital	Centre lower part of the margin of the orbit
17. Ecthocanthion[a]	The lateral corner of the eye
18. Endocanthion[a]	The medial corner of the eye
19. Inferior malar	Lower part of the jaw
20. Lateral orbit	Line between the eye and the centre of the zygomatic arch
21. Zygomatic arch	Most lateral curvature of the zygomatic bone
22. Supraglenoid	Above and forward the acoustic meatus
23. Alare[a]	The most lateral point on the "wing" of the nose
24. Gonion	Point located in the jaw line at the level of the angle between the posterior with the inferior borders of the mandible
25. Supra-M2	Point located in the alveolar process at the level of the middle of the second upper molar
26. Occlusal line	Point in the extremity of the anterior portion of the mandibular ramus at the horizontal level of the cheilion
27. Infra-M2	Point located in the alveolar process at the level of the middle of the second lower molar
28. Supra-canine[a]	Point located in the alveolar process at the level of the middle of the upper canine
29. Infra-canine[a]	Point located in the alveolar process at the level of the middle of the lower canine
30. Cheilion[a]	This area corresponds to the labial commissure (i.e., the corner of the mouth)
31. Mid-ramus[a]	Point at the centre of the mandibular ramus

[a] Additional anatomical landmarks.