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# EVALUATION OF SOFT TISSUE THICKNESSES WITH THE PURPOSE OF FACIAL RECONSTRUCTION IN BRAZILIAN

**Abstract:** The auxiliary technique of identification known as Facial Reconstruction makes possible to obtain face identification from the contours of the tissue around the skull, increasing the probabilities of recognition. The reliability of this technique depends on the evaluation of the thickness of the soft tissues that covers the skull. Those measurements were evaluated on a sample of studied cadavers in São Paulo state, Brazil. The thickness has been manually measured using the needle puncture technique in 10 anatomical landmarks of the skull located in the midleline and in 11 bilateral points of 40 cadavers of both sexes, aged between 17 and 90 years, classified by skin color and nutritional state. Descriptive statistics calculations were made accordingly to T-tests, ANOVA and Tukey tests. Those calculations, when compared with other populations studies, showed different results, that lead to the need of using a specific table with values of the local population to implement the technique of facial reconstruction in skulls without an attributable identity.

## Introduction

Identification of corpses, bones or fragments is a fundamental in the field of Forensic Sciences and has legal and humanitarian implications. Data from post-mortem exams will be useless if it can't be correlated with those from someone with a previously known identity. In the past one hundred and five years, several studies have been performed correlating the external appearance of people with the soft tissue thickness over the skull base. Facial Reconstruction, as an auxiliary identification technique, allows the reconstruction of soft tissue contours over the skull and the face, thus increasing the probability of facial recognition. The reliability of this technique, however, depends on the evaluation of the mean values of soft tissue thicknesses observed in a given population. Existing studies for different ethnical groups, mostly from isolated populations with strong common characteristics, have produced models that led to questionable results when applied to mixed ethnical characteristics populations.

The purpose of this study is to assess the measurements of the thickness of soft tissue that covers anatomical landmarks of the skull using a population sample of corpses in Guarulhos, São Paulo, Brazil. Guarulhos is located in the metropolitan

area of Sao Paulo (Brazil's largest city), and is made up of a highly mixed population consisting of several different racial types. Thus the cadaver sample is comparable to the composition of the Brazilian population as a whole in terms of skin color.

This study was approved by the Committee on Ethics in Research of Faculdade de Odontologia da Universidade de São Paulo, Brazil (Protocol nº 21/07).

## Materials and Methods

For an initial investigation, defining a depths standards to be applied in the Brazilian population, used a sample of 40 corpses (26 male and 14 female), with ages between 17 and 90 years, classified per skin color and nutritional state, autopsied in the "Seção Técnica de Verificação de Óbitos" (Technical Section of Death Cause Verification) in Guarulhos, São Paulo, Brasil.

Soft tissue thickness was measured by the needle puncture method in 10 craniometrical points and 11 bilateral points (used by Rhine and Campbell, 1980 [1]), described in Table I, by 2 examiners within 12 hours from death to avoid any post-mortem distortion effect.

Because Brazil has one of the most heterogeneous populations in the world [2,3], the Von Luschan chromatic scale was used to classify skin color with values of: 10 to 19 for leucoderms (alike Caucasian), 20 to 23 for xantoderms (native indians and immigrants of Asian origin), 24 to 29 for faioderms (descendents of interbreeding between black and white ancestors, with different skin tones), and 30 to 36 for melanoderms (alike Afro-Americans). The Von Luschan scale establishes different color tones that can be compared with a part of the skin unexposed to the sun. This classification was complemented by somatometric and somatoscopic observations for Brazilian anthropological types as suggested by Roquette Pinto [4].

Body mass index (BMI) was used to classify the sample's nutritional status. BMI was calculated using the following formula: $kg/m^2$. Height and weight were measured during the autopsies. The following classification was used: lean, when BMI < 20 (N= 11); normal, when 20 < BMI < 24.9 (N=13); overweight, when 25 < BMI < 29.9 (N=10); and obese, when BMI > 30 (N=6).

Measurements were taken by puncturing the skin with a thin stainless steel dental needle with a silicone marker stop. The needles were introduced in the previously located anatomical landmarks, perpendicular to the skin until they met bone resistance. The marker was then slid in to touch the surface of the skin, without pressing or deforming it. A caliper was used to measure the depth from the tip of the needle to the base at the skin.

Descriptive statistics were calculated using the Statistical Program for Social Sciences (SPSS) [5]. Student's T-test was used to compare two groups, ANOVA was used to compare more than two groups and Tukey's test, when there was indication of a statistically significant difference – $p < 0.05$. The averages were compared to those in the studies of Rhine and Campbell [1] and Rhine and Moore [6] for individuals with the same skin color and gender.

## Results

A statistical model was established considering biological sex, age, skin color and nutritional state, between examiners measurements differences also being evaluated. Measurements from the two examiners had a very good statistical correlation for all points ($p<0.05$).

Measured thickness values were found greater for males, with 10 out of 32 measurements found statistically significant when tested with T- Student. ANOVA test of the sample showed significant differences due to nutritional state for 3 measurements in the mean line and 11 of the bilateral, proportional to fat quantity in the face, and that age was not significant.

Ethnical variable due to skin color, analyzed using ANOVA test showed a statistical significant characteristic between different groups only for the Nasion craniometrical point (Table II). However, these data showed to be different from other studies for different populations with the same skin color.

## Discussion

The methodologies of measuring the thickness of soft tissues on the face have limitations, but the ease of obtaining them through the puncturing with needles at the points of the faces corresponding to those existing in the skull, has made this method withstand to the development of more technologically advanced methods , as can be seen in recent publications [7,8]. Non-invasive imaging diagnostic techniques will, undoubtedly, provide better accuracy and precision [9,10,11,12]. Such exams, however, are not always radiation hazard free and it is not possible to gather data for all necessary points to the Facial Reconstruction techniques without increasing radiation exposure time on patients being examined for any pathology. It may be also difficult to locate craniometric points and corresponding tissue depth.

Differences in the thickness of facial tissues related to sex, age, ethnicity and nutritional status have been singled out as the shortcomings of the Facial Reconstruction technique and have been studied by several authors and also in this work. The results indicate that the males present greater thickness of soft tissue than females, so those differences should be considered for the use of Facial Reconstruction.

Although several authors [13,14] showed that adult and child faces differ, it was not possible to correlate changes due to aging. In our study, only three out of thirty-two variables were found to be statistically different, those being above 55 years age. In the studied sample, 65% of the individuals were above 55 years age, so not allowing a statistical analysis of any aging effect. The chances that data related to age can pose some additional information for Facial Reconstruction Technique are limited to the determination of differences between children and adults.

The face will change due to different nutritional states because of fat found in Infraorbital, Zygomatic, and Malar regions and, when this information is needed, we agree with the suggestion of Starbuck and Ward [15] of creating different versions of a Facial Reconstruction considering several different nutritional states.

Data obtained with this study helped to realize that the highly mixed Brazilian population present statistically different results from those found in other populations that had different results between leucoderms and melanoderms people [1, 6, 7, 8, 9, 11, 12, 16].

We can see that even with no significant differences related to the color of the skin for this group studied in our population; these differences appear when compared to other populational groups for the same color of skin. This, Brazilians leucoderms have different thickness measures of soft tissues compared to the faces of American Caucasians [6]. Similar differences were also found for Brazilians melanoderms and African-Americans [1]. This study is based on the methodology described by Rhine and Campbell [1], who are the most cited and discussed in the available literature. The same craniometric points used for the measurements and the same measurement techniques indicate that the differences found are real. Afro-Americans in general have thicker soft tissues in the face when compared with Brazilian melanoderms of both genres and Caucasian Americans have the greater thickness of the facial bilateral points. Thickness tables produced for different populations will result in different faces being reconstructed over a single skull. These findings may corroborate with the current theories that there are no distinct races among humans, but morphological characteristics prevailing in different groups.

## Conclusions

Our research indicates that the use of Soft Tissue Depth standards from other population groups, like North Americans, in the Brazilian population would result in an inaccurate representation of individuals while alive. Thus, we recommend to Facial Reconstruction in Brazil to use our published tissue depths (Table III). The use of values in our population is likely to perform more accurate Facial Reconstruction, increasing the chances of a Brazilian be recognized through the use of this technique.

## References


[1] J.S. RHINE, H.R. CAMPBELL. Thickness of facial tissues in American blacks. J Forensic Sci 25:847-858, 1980.

[2] F.C. PARRA, R.C. AMADO, J.R. LAMBERTUCCI, J. ROCHA, C.M. ANTUNES, S.D.J. PENA. Color and genomic ancestry in Brasilians. Proc Natl Acad Sci USA.;100(1):177-182, 2003.

[3] S.D.J. PENA. Retrato molecular do Brasil. In:Seminário de tropicologia: o Brasil no limiar do século XXI, 2000, Recife. Anais. Available at URL: http://www.tropicologia.org.br/CONFERENCIA/2000retrato_molecular.html [22 abr 2008]

[4] E. ROQUETTE-PINTO. Nota sobre os typos anthropologicos do Brasil. Archivos do Museu Nacional, Rio de Janeiro 30 :303-331, 1929.

[5] STATISTICAL PROGRAM FOR SOCIAL SCIENCES (SPSS) for Windows software (SPSS Inc., Chicago, version 14.0).

[6] J.S. RHINE, C.E. MOORE, WESTON JT. Facial reproduction: tables of facial tissue thickness of American caucasoids in forensic anthropology. Maxwell Museum Technical Series n.1, University of New Mexico,Albuquerque, 1984.

[7] E. SIMPSON, M. HENNEBERG. Variation in soft-tissue thicknesses on the human face and their relation to craniometric dimensions. Am J Phys Anthropol; 118 :121-133, 2002.

[8] M. DOMARACKI, C.N. STEPHAN. Facial Soft Tissue Thicknesses in Australian Adult Cadavers. J. Forensic Sci 51:(1), 5-10, 2006.

[9] G.V. LEBEDINSKAYA, T.S. BALUEVA, E.V. VESELOVSKAYA. Principles of facial reconstruction. In: M.Y. ÌSCAN, R.P. HELMER. Forensic analysis of the skull:craniofacial anlysis, reconstruction and identification. New York :Wiley-Liss, 183-198, 1993.

[10] S. DE GREEF, P. CLAES, D. VANDERMEULEN, W. MOLLEMANS, P. SUETENS, G. WILLEMS. Large-scale in-vivo Caucasian facial soft tissue database for craniofacial reconstruction. Forensic Sci Int 159S :S126-S146, 2006.

[11] D. SAHNI, SANJEEV, G. SINGH, I. JIT, P. SINGH. Facial soft tissue thickness in northwest Indian adults. Forensic Sci Int. 176 :137-146, 2008.

[12] M.W. JONES. Facial reconstruction using volumetric data. Vision, Modeling and Visualisation; 21-23:600-8, 2001.

[13] T.N. GARLIE, S.R. SAUNDERS. Midline facial tissue thicknesses of subadults from longitudinal radiographic study. J Forensic Sci. 44(1):61-67, 1999.

[14] M.A. WILLIAMSON, S.P. NAWROCKI, T.A. RATHBUN. Variation in midfacial tissue thickness of African-american children. J Forensic Sci 47(1) :25-31, 2002.

[15] J.M. STARBUCK, R.E. WARD. The affect of tissue depth variation on craniofacial reconstructions. Forensic Sci. Int 172 :130-136, 2007.

[16] H.A. HASHIM, S.F. ALBARAKATI. Cephalometric soft tissue prolife anlysis between two different ethnic groups: a comparative study. J Contemp Dent Pract. 4: 260-273, 2003.

| ANATOMICAL LANDMARKS | DESCRIPTION |
|---|---|
| **MidlinePoints** | |
| 1. Supraglabella | Foremost point in the midline, above Glabella |
| 2. Glabella | Most forward projecting point of the forehead in the midline at the level of the supraorbital ridges |
| 3. Nasion | Midline of the nasofrontal suture |
| 4. Rhinion | End of the nasal bone |
| 5. Mid-philtrum | Midline of the intranasal depression |
| 6. Supradentale | Center jaw, between the upper incisives |
| 7. Infradentale | Center jaw, between the lower incisives |
| 8. Supramentale | Most posterior midline point, above the chin in the jaw between the infradentale and the pogonion |
| 9. Mental eminence | The most prominent point of the chin |
| 10.Menton | Lowest point of the chin |
| **Bilateral Points** | |
| 11.Frontal eminence | Bony projection of the ectocranial surface of the frontal bone |
| 12.Supraorbital | Center upper part of the margin of the orbit |
| 13.Suborbital | Center lower part of the margin of the orbit |
| 14.Inferior malar | Lower part of the jaw |
| 15.Lateral orbit | Line between the eye and the center of the zygomatic ach |
| 16. Zygomatic arch | outermost point in the zygomatic arch from a vertical plan view |
| 17.Supraglenoid | Above and forward the acoustic meatus |
| 18. Gonion | The outer margin of the angle of the mandibule |
| 19. Supra M2 | Above the second upper molar |
| 20. Occlusal line | Point in the jaw in the plane of dental occlusion |
| 21. Sub M2 | Bellow the second lower molar |

Table I – Anatomical landmarks considered in present study

| Nasion p=0,008 | | N | Means/mm |
|---|---|---|---|
|  | faio | 9 | 4.7 |
| | **leuco** | **22** | **6.4** |
| | melano | 8 | 4.7 |
| | xanto | 1 | 4.0 |
| | | 40 | |

Table II – Means (mm) in Nasion craniometrical point for skin color

| Localizacion | Means/mm | | Localizacion | Means/mm | |
|---|---|---|---|---|---|
| | ♂ (n=26) | ♀(n=14) | | ♂ (n=26) | ♀(n=14) |
| MidlinePoints | | | Bilateral Points | | |
| **Supraglabella** | **5.0** | **4.3** | **Frontal eminence** | **4.9** | **3.9** |
| Glabella | 5.5 | 4.6 | SupraOrbital | 6.9 | 5.8 |
| **Nasion** | **5.9** | **5.0** | **SubOrbital** | **6.5** | **6.0** |
| Rhinion | 5.2 | 4.2 | Inferior malar | 11.2 | 10.0 |
| **Filtro Médio** | **10.6** | **7.7** | **Lateral orbit** | **9.1** | **9.2** |
| Supradentale | 9.1 | 8.7 | Zygomatic arch | 9.2 | 8.8 |
| **Infradentale** | **10.6** | **9.4** | **Supraglenoid** | **11.6** | **10.8** |
| Supramentale | 11.0 | 9.1 | Gonion | 12.7 | 10.9 |
| **Mental eminence** | **10.6** | **9.4** | **SupraM2** | **16.4** | **14.4** |
| Menton | 10.4 | 8.7 | Occlusal line | 14.4 | 11.7 |
| | | | **SubM2** | **14.6** | **11.3** |

Table III – Facial soft tissues thickness in Brazilians (mm)