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Facial Tissue Thickness in Chilean Cadavers with Medico-Legal Purposes

Grosores Tisulares Faciales en Cadáveres de Individuos Chilenos con Fines Médicos-Legales

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ABSTRACT: The reconstruction of facial features is a key process in human identification with anthropological methods, and represents the ultimate aim of forensic facial reconstruction. This study aimed to record the values of facial tissue thickness of the Chilean population to have a reference table with forensic purposes. We used 40 Chileans cadavers of both sexes, with dates of death between 3 and 48 hours (mean 13.05 hours, SD 10.49) kept in cold storage at -4 º C, aged between 23 and 76 years (mean 45.95 years, SD 11.23), with a BMI average 25.38 (SD 2.27) in men and 26.41 (SD 3.09) in females. We analyzed the facial tissue thicknesses in 20 cephalometric points, eight median and six bilateral paramedian, using the needle puncture--method. We evaluated the presence of sexual dimorphism. The men have a greater thickness at the midpoints, unlike women, where thickness was greater in the paramedian points. However, the differences were significant only in the nasion point. Several studies have reported differences in tissue thickness between men and women, that would justify their systematic determination to develop protocols for facial reconstruction for forensic sculpture. In our study there were no differences, suggesting that different methods of preservation, postmortem time and BMI have influence on gender differences and should be considered in generating population data.

KEY WORDS: tissue thickness, facial reconstruction, human identification.

INTRODUCTION

The reconstruction of facial features is a key process of human identification with anthropological methods and represents the ultimate goal of reconstruction technique for forensic facial reconstruction. The expert presented a scenario of an individual would present after a skull reconstruction. There are many important aspects of this technique, the state of the skull, the context in which it was found and the existence of data showing facial features of individuals of the population that belongs to skull found. One of the most relevant data to conduct forensic facial reconstruction is the thickness of facial soft tissue, which varies according to genetic determinants and their interaction with the environment. That is why there is great variability between populations highlighting issues such as race they belong, the individual's body mass, skin color, sex, among other (De Greef *et al*., 2009).

In consideration of biological parameters, we can consider its action on facial appearance, approaching the real parameters. In this regard, it is interesting to recall that knowledge of the average measures of tissue thicknesses in different populations, represents a contribution not only descriptive of them, but can also play a practical role in the forensic identification (Suazo *et al.,* 2007a), as in planning reconstructive surgery.

In the forensic context, the procedure for reconstruction of facial tissues is carried out using a moldable material on the head bone. Thefore reproducing the soft structures of the face (Rodríguez, 2004), this being an approximation to reality, because to the limits of the technique is unable to reconstruct the environmental conditions under which the individual developed, diseases,may have had plastic surgery

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since this type of event in the life of the person are not reflected in bone structure, or nutritional status present (Policía de Investigaciones de Chile, 2007).

Tissue thickness values used in facial reconstruction, are often obtained from research bodies of origin very different from our population, which adds the to the disadvantage of the physical phenomenon of dehydration of soft tissues (10-18 grams / day / weight) in addition to the rigor mortis that affects the muscle fibers (De Greef, 2006; Suazo *et al.,* 2007b).

The measurements of facial thickness in cadavers in situ have not been sufficiently studied in Chile (Policía de Investigaciones de Chile), also taking into account that there are variations in these measurements in the population attributable to geographic and ethnic factors present in our country (Tedeschi-Oliveira *et al.,* 2009). The aim of this research is to determine the facial tissue thicknesses median and paramedian cephalometric points (De Greef *et al.*, 2006) of a number of bodies of Chilean adults in the region of Maule, preserved in cold chambers in the medicolegal institute, with a date of death of no more than 48 hours.

The result of this research will contribute to provide new data on the estimated thickness of facial tissues in our population, which is useful in the field of forensic identification, specifically in forensic facial reconstruction will obtain copies modeled with physical characteristics more accurate, resulting in time reduction in the identification process.

MATERIAL AND METHOD

We designed a cross-sectional study to determine the facial tissue thickness in 20 facial points. 40 bodies were used, from the Medicolegal Institute of Curicó, Maule Región, Chile; kept in cold chamber at -4 º C, aged between 23 and 76 years (mean 45.95 years, SD 11.23), relationship weight class with an average BMI 25.38 men (SD 2.27) and women 26.41 (DS 3.09), Caucasian skin color and whose death dates ranged between 3 and 48 h (mean 13.05 hours, DS 10.49).

Table I. Median and paramedian cephalometric points used in this study, according to Suazo *et al.* (2007a).

Median points	
Trichion	Point located in the midline at the hairline area (as a variable measure was chosen to 6 cm from the glabella).
Supraglabella	Point located in the medium to 2 cm above the glabella.
Glabella	Most prominent point on the frontal sinus, situated between the eyebrows in the midline, and identical to the glabella on the frontal bone.
Nasion	It represents the union of the nasal bone with the frontal bone, ie the frontonasal suture in the most posterior point of the curve on the bridge of the nose, which has a place in the soft tissue in the concave point covering the area retruded of the frontonasal suture.
A Downs	Point of the margin membranous upper lip.
B Downs	Lowest point on the margin membranous lower lip.
Pogonion	Most anterior point of the mandibular midline, in the soft tissue for the most prominent or anterior point of the soft tissue chin in the midline.
Gnathion	Higher point is more forward curvature observed profile of the mandibular midline in the soft tissue lies between the anterior and inferior point of the chin in the midline.
Paramedian points*	
Supraciliar	Lateral point located in the most prominent part of the frontal bone (right and left).
Supraorbital	Highest point of the bony orbit (right and left).
Exocanthion	Point on the lateral corner of the orbital cavity (right and left).
Infraorbital	The lowest point in the bottom of each orbit (right and left).
Zygion	Most lateral point of zygomatic bone, seen from front (left and right).
Gonion	Above and outbound point angle formed by the union of the branch and the body of the mandible in its posterior region (right and left).

*Paramedian points in this study are bilateral. therefore considered right left.

Cadavers were included with a complete registry of sex, age, weight, size and color, with dates of death no longer than 48 hours. No bodies were found with evidence of trauma or facial alteration, with different skin color to white bodies in poor condition and individuals under 23 years.

Procedure. Using a blue aniline pencil were identified and scored 20 cephalometric points, of which eight were found in the midline, and 6 are paramedian, bilateral, which are described in Table I.

At each point was made the thickness of the integument by the insertion of a needle envaselinada 40 mm long and 27 Gauge, which introduced a silicone cap. The insertion was made perpendicular to the skin surface, preventing the formation of creases, deepening to find bone contact. We measured the distance between the tip of the needle and the beginning of the rubber, using a millimeter ruler.

Analysis Plan. Based on certain measurements for each of the bodies were obtained descriptive statistics (mean, standard deviation). Then using the SPSS 15.0 statistical program contrasting the average tissue thicknesses of men and women using t test with $p < 0.05$.

RESULTS

The greatest thicknesses are found in tissue midpoints of the lower third of the face (Downs A, Downs B and Pogonion points). Table II shows the detail of the descriptive statistics of facial soft tissue thickness in relation to cephalometric points measured in 40 individuals.

Table III shows the values shows the distribution of the values of tissue thickness in the measured points

Table II. Descriptive statistics of facial soft tissue thickness in relation to cephalometric points.

	n	Minimum	Maximum	Mean	SD
Trichion	40	3.0	6.0	4.140	0.7880
Supraglabella	40	2.3	6.6	4.475	1.0139
Glabella	40	3.0	6.0	4.638	0.6566
Nasion	40	3.0	7.0	5.050	0.9290
A Downs	40	6.0	16.3	10.168	2.1818
B Downs	40	7.0	13.0	10.150	1.7080
Pogonion	40	6.6	12.6	10.080	1.2005
Gnathion	40	4.6	11.0	6.790	1.2146
R Supraciliar	40	3.0	6.0	4.200	0.8210
R Supraorbital	40	3.0	7.0	5.510	1.0150
R Exocanthion	40	3.3	7.0	4.825	0.9992
R Infraorbital	40	1.3	7.0	4.245	1.2549
R Zygion	40	3.3	11.0	7.288	1.9857
R Gonion	39	7.0	14.0	10.23	2.0170
L Supraciliar	40	2.0	6.6	4.030	1.0125
L Supraorbital	40	3.0	7.6	5.380	1.0816
L Exocanthion	40	2.6	7.0	4.640	1.1033
L Infraorbital	40	1.0	6.6	3.647	1.3795
L Zygion	40	5.0	12.0	6.932	1.4503
L Gonion	40	7.0	15	9.380	1.8560
No valid (as listed)	39				

*R: Right; **L: Left.

Table III. Distribution of tissue thickness values measured in points by sex.

	Sex	n	Mean	SD	p Value
Trichion	Men	27	4.160	0.769	0.794
	Women	13	4.09	0.858	
Supraglabella	Men	27	4.563	0.9736	0.436
	Women	13	4.292	1.1109	
Glabella	Men	27	4.615	0.6562	0.757
	Women	13	4.685	0.6817	
Nasion	Men	27	5.290	0.936	0.013*
	Women	13	4.530	0.696	
A Downs	Men	27	10.615	2.1783	0.061
	Women	13	9.238	1.9504	
B Downs	Men	27	10.400	1.665	0.186
	Women	13	9.630	1.746	
Pogonion	Men	27	9.952	1.2641	0.337
	Women	13	10.346	1.0525	
Pogonion	Men	27	6.641	0.8436	0.268
	Women	13	7.100	1.7602	
R Supraciliar	Men	27	4.170	0.796	0.789
	Women	13	4.250	0.903	
R Supraorbital	Men	27	5.440	1.082	0.541
	Women	13	5.65	0.880	
R Infraorbital	Men	27	4.741	1.0059	0.449
	Women	13	5.000	1.0017	
R Exocanthion	Men	27	4.215	1.3381	0.830
	Women	13	4.308	1.1102	
R Zygion	Men	27	7.189	2.1034	0.657
	Women	13	7.492	1.7783	
R Gonion	Men	27	10.26	2.278	0.895
	Women	13	10.17	1.437	
L Supraciliar	Men	27	4.048	1.1071	0.873
	Women	13	3.992	0.8210	
L Supraorbital	Men	27	5.330	1.0876	0.677
	Women	13	5.485	1.1052	
L Infraorbital	Men	27	4.581	1.1039	0.635
	Women	13	4.762	1.1369	
L Exocanthion	Men	27	3.478	1.4061	0.268
	Women	13	4.000	1.3045	
L Zygion	Men	27	6.630	1.0848	0.056
	Women	13	7.562	1.9107	
L Gonion	Men	27	9.180	1.936	0.333
	Women	13	9.790	1.672	

* $p<0.05$ statistically significant value. **R: Right; ***L: Left.

Table IV. Studies in different countries on the facial tissue thickness in cadavers and *in vivo*.

Variable	Rhine & Campbell (1980)		Rhine & Moore (1984)		Tedeschi-Oliveira *et al.* (2006)		Suazo *et al.* (2007)		Suazo *et al.* (2008)		Domaracki & Stephan (2005)		De Greef *et al.* (2006)		Miyasaka (1999)		Barriga *et al.* (2010) (Our study)
	M (mm)	W (mm)	M (mm)	W (mm)	M (mm)	W (mm)	MW (mm)	W (mm)	M (mm)	W (mm)	M (mm)	W (mm)	M (mm)	W (mm)	M (mm)	W (mm)	M (mm)
Median line																	
Trichion	NC	NC	NC	NC	NC	NC	5.4	3.5	4.9	NC	NC	NC	NC	NC	NC	NC	4.2
Supraglabella	NC	NC	NC	NC	NC	NC	4.6	3.4	4.5	NC	NC	NC	5.1	4.9	NC	5.1	4.5
Glabella	6.2	6.2	5.2	4.7	5.7	4.7	5.5	5.6	5.4	NC	6.9	5.8	5.9	5.8	NC	5.6	4.6
Nasion	6.0	5.7	6.5	5.5	6.7	5.5	5.9	5.5	5.1	NC	6.7	6.2	7.2	7.2	NC	2	5.3
Rhinion	3.7	3.7	3.0	2.7	5.3	4.6	NC	NC	NC	NC	3.3	3.0	NC	NC	NC	NC	NC
Midnasal	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	3.2	2.9	NC	NC	NC
Subnasal	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	13.4	13.7	NC	NC	NC	11.9	NC
Filtrum	12.2	11.2	10.0	8.5	10.7	7.1	NC	NC	NC	NC	10.7	8.9	10.4	9.1	NC	NC	NC
Supradental	14.0	13.0	9.7	9.0	8.8	9.8	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Infradental	15.0	15.5	11.0	10.0	10.0	9.6	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Downs A	NC	NC	NC	NC	NC	NC	11.2	8.6	11.5	NC	NC	NC	NC	NC	NC	NC	10.6
Downs B	NC	NC	NC	NC	NC	NC	10.2	9.6	10.7	NC	NC	NC	NC	NC	NC	NC	10.4
Supramentonian	12.0	12.0	10.7	9.5	11.1	9.7	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Mental eminence	12.2	12.2	11.2	10.0	11.0	9.3	NC	NC	NC	NC	NC	NC	12.2	11.6	NC	NC	NC
Mentolabial sulcus	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	11.8	9.6	NC	NC	NC	12.7	NC
Pogonion	NC	NC	NC	NC	NC	NC	11.6	11.0	11.3	NC	12.2	12.3	NC	NC	NC	12	9.9
Gnathion	NC	NC	NC	NC	NC	NC	6.6	6.2	8.0	NC	NC	NC	NC	NC	NC	6.6	6.6
Chin	8.0	7.7	7.2	5.7	10.7	8.4	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Bilateral																	
Frontal	NC	NC	4.2	3.5	5.1	3.1	NC	NC	NC	NC	NC	NC	5.2	5.0	NC	NC	NC
Rigth Frontal	8.7	8.0	NC	CN	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Left Frontal	8.2	8.0	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Rigth Superciliar	NC	NC	NC	NC	NC	NC	5.7	5.5	5.8	NC	NC	NC	NC	NC	NC	NC	4.2
Supraorbital	NC	NC	8.2	7.0	7.8	6.0	NC	NC	NC	NC	9.2	8.1	6.5	6.5	NC	NC	NC
Rigth Supraorbitario	4.7	4.5	NC	NC	NC	NC	5.8	5.7	7.1	NC	NC	NC	NC	NC	NC	NC	5.4
Infraorbital	NC	NC	5.7	6.0	6.4	7.1	NC	NC	NC	NC	NC	NC	11.6	11.1	NC	NC	NC
Rigth Infraorbital	7.7	8.2	NC	NC	NC	NC	4.4	3.9	5.8	NC	NC	NC	NC	NC	NC	NC	4.7
Rigth Exocanthion	NC	NC	NC	NC	NC	NC	NC	NC	4.0	NC	NC	NC	NC	NC	NC	NC	4.2
Rigth Zygion	NC	NC	NC	NC	NC	NC	NC	NC	7.7	NC	NC	NC	NC	NC	NC	NC	7.2
Left Superciliar	NC	NC	NC	NC	NC	NC	5.8	5.5	5.8	NC	NC	NC	NC	NC	NC	NC	4.0
Left Supraorbital	4.7	4.5	NC	NC	NC	NC	5.7	5.6	6.9	NC	NC	NC	NC	NC	NC	NC	5.3
Left Exocanthion	NC	NC	NC	NC	NC	NC	3.7	3.7	3.9	NC	NC	NC	NC	NC	NC	NC	3.5
Left Infraorbital	7.5	8.5	NC	NC	NC	NC	NC	NC	5.8	NC	NC	NC	NC	NC	NC	NC	4.6
Inferior zygomatic	NC	NC	13.2	12.7	NC	NC	NC	NC	NC	NC	NC	NC	20.7	21	NC	NC	NC
Rigth inferior zygomatic	17.0	17.7	NC	NC	12.7	7.6	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Left inferior zygomatic	16.2	17.2	NC	NC	11.2	8.0	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Lateral orbital	NC	NC	10.0	10.7	NC	NC	NC	NC	NC	NC	NC	NC	10.7	8.4	NC	NC	NC

Right lateral orbital	13.2	12.7	NC	NC	10.9	7.9	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Left lateral orbital	13.0	14.2	NC	NC	9.5	7.5	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Zygomatic arch	NC	NC	7.2	7.5	NC	NC	NC	NC	NC	NC	NC	NC	8.1	8.4	NC	NC	NC	NC
Right zygomatic arch	8.5	9.0	NC	NC	9.3	11.4	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Left zygomatic arch	8.7	9.2	NC	NC	8.9	9.1	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Supraglenoid	NC	NC	8.5	8.0	NC	NC	NC	NC	NC	NC	NC	NC	11.0	10.4	NC	NC	NC	NC
Rigth supraglenoid	11.7	12.2	NC	NC	11.6	9.1	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Left supraglenoid	11.7	12.0	NC	NC	11.5	11.6	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Gonion	NC	NC	11.5	12.0	NC	NC	NC	NC	NC	NC	NC	NC	18.7	17.6	NC	NC	NC	NC
Rigth Gonion	14.7	14.2	NC	NC	11.5	9.4	NC	NC	NC	NC	NC	NC	NC	NC	NC	12.8	10.3	10.2
Left Gonion	14.2	14.2	NC	NC	14.2	11.0	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	9.2	9.8
Left Zygion	NC	NC	NC	NC	NC	NC	NC	NC	6.5	NC	NC	NC	NC	NC	NC	NC	6.6	7.6
SupraM2	NC	NC	19.5	19.2	NC	NC	NC	NC	NC	NC	NC	NC	29.2	29.2	NC	NC	NC	NC
Rigth SupraM2	22.0	21.2	NC	NC	16.8	16.2	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Left SupraM2	22.0	20.7	NC	NC	17.3	13.9	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Occlusal plane	NC	NC	18.2	17.0	NC	NC	NC	NC	NC	NC	NC	NC	21.8	21.0	NC	NC	NC	NC
Rigth Occlusal plane	19.0	19.2	NC	NC	14.2	14.4	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Left Occlusal plane	19.5	18.2	NC	NC	16.0	11.2	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
SubM2	NC	NC	16.0	15.5	NC	NC	NC	NC	NC	NC	NC	NC	21.4	22.3	NC	NC	NC	NC
Rigth SubM2	16.5	17.2	NC	NC	15.0	12.0	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Left SubM2	15.7	16.7	NC	NC	15.0	11.1	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

* NC: Not considered; ** M: Men; *** W: Women; **** HE: Embalmed corpses (Men and Woman mixed).

by gender. The data show significant differences ($p < 0.05$) only at the point nasion ($p = 0.013$).

In general, men have a greater thickness in the middle cephalometric points (Trichion, supraglabela, nasion, A and B Downs which corresponds to 62.5% of the sample), unlike what happened in the paramedian points, in which, out of 12 measured points (100%), 10 (83.3%), for women have an increased thickness.

DISCUSSION

The facial reconstruction may be an element that has a high value in the field of forensic investigation. This allows the forensic sculptor to estimate the volume to be modeled on a skull surface, using certain cephalometric reference points.

By analyzing the thickness of facial soft tissue in general, men had greater values in the midpoints and women in the paramedian points. However, only the nasion point (higher in men) was significantly different. These results partially agree with previous studies (De Greef *et al.*, 2006; Suazo *et al*., 2007b; Tedeschi-Oliveira *et al*.), Table IV shows a comparative table of tissue thickness measured with different methods and different populations.

In assessing the results with those obtained from comparable populations, in them the distribution of differences is similar, despite the significantly different number of points was greater, justifying a preliminary anthropological analysis to identify sex, prior to forensic facial reconstruction (De Greef *et al*., 2006; Suazo *et al.,* 2008a). These studies were conducted in cadavers and in vivo, in both cases the individuals had a body mass index (BMI) was normal. In our study analyzed individuals had a higher than normal BMI in both men and women, suggesting that weight-height ratio is important for the distribution of adipose tissue subcutaneously into the fabric of the facial region. This finding is important in planning the forensic facial reconstruction process as perspective the importance of determining the sex before beginning the process.

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RESUMEN: La reconstrucción de la fisonomía facial es una de las claves del proceso de identificación humana con métodos antropológicos y representa el fin último de la reconstrucción con plastía forense. El presente estudio busca registrar los valores de los grosores tisulares faciales de la población chilena para tener una tabla de referencia en el uso con fines médico legales. Se utilizaron 40 cadáveres de individuos chilenos de ambos sexos, con una data de muerte de entre 3 y 48 horas (media 13,05 horas, D.S. 10,49) conservados en cámaras frías a -4º C, con edades entre 23 y 76 años (media 45,95 años, D.S 11,23), IMC promedio hombres 25,38 (DS 2,27) y mujeres 26,41 (DS 3,09). Se analizaron los grosores tisulares faciales en 20 puntos cefalométricos, 8 medianos y 6 paramedianos bilaterales, utilizando el método de punción por agujas. Se evaluó la presencia de dimorfismo sexual. Los hombres presentan un mayor espesor en los puntos medianos, a diferencia de las mujeres en las que grosor fue mayor en los puntos paramedianos. Sin embargo las diferencias sólo fueron significativas en el punto Nasion. Diversos estudios han reportado diferencias en los grosores tisulares entre hombres y mujeres, que justificarían su determinación sistemática al desarrollar protocolos de reconstrucción por plastía forense. En nuestro estudio no se encontraron estas diferencias, lo que sugiere que distintos métodos de conservación, tiempo transcurrido postmortem e índice de masa corporal tiene influencia en las diferencias entre sexos por lo que deben ser consideradas al generar datos poblacionales.

PALABRAS CLAVE: grosor tisular, plastía forense, identificación Humana.

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