Original Article

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Peri-orbital bone dimensional analysis using computed tomography for placement of osseointegrated implants

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Abstract

Craniofacial osseointegrated implants enabled producing implant-retained facial prosthesis, namely the orbital prosthesis. **Aim:** To evaluate the length and width of the bone structure of the peri-orbital region and to present the method validation. **Methods:** Computed tomography scans of 30 dry human skulls were obtained in order to register linear length and width measurements of the peri-orbital region. Two examiners made the measurements twice with intervals of at least 7 days between them. Data were analyzed by descriptive statistics and the paired Student's t-test was used as inferential technique (SAS, α=0.05). **Results:** In most cases, the intra- and inter-examiner variations were not significant ($p>0.05$). Therefore, the method proposed was considered as precise and valid for the measurement of the peri-orbital region. The measured points correspond to the hours of a clock. The major lengths were observed at 1 h (18.32 mm) for the left peri-orbital bone and at 11h (19.28 mm) for the right peri-orbital bone, followed by the points situated at 2h (13.05 mm) and 12h (11.37 mm) for the left side and at 10 h (12.34 mm) and 12 h (11.56 mm) for the right side. It was verified that the three points with lowest values followed the same anatomical sequence in the supraorbital rim for the right and left orbits, showing compatibility with the insertion of the intraoral osseointegrated implants. The medial wall of both orbits did not present sufficient length to allow the insertion of intraoral or craniofacial implants. **Conclusions:** The largest width points were observed in the supraorbital rim and in the infralateral region of both orbits and those of smallest width were found in the supralateral region of both orbits.

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Introduction

Oral and Maxillofacial Prosthodontics is the dental specialty responsible for the fabrication of intraoral and extraoral prostheses, indicated when maxillofacial regions are lost due to diseases, cancer surgery or trauma. The application of the osseointegration principles for the restoration of craniofacial defects using facial prostheses retained by implants, enabled by the emergence of osseointegrated implants, has given rise to significant advances, overcoming the limitations of conventional retention methods, by either elastic, adhesive or eye glass frames[1-4]. Implant-retained dentures provide a better quality of life, which ultimately, is the ideal for any rehabilitation process[5-6].

For the construction of implant-supported orbital prostheses, the implants may be placed in the supra-orbital margin of the frontal bone in the infra-orbital rim, in the zygomatic process of the frontal bone and frontal process of the zygomatic bone[7-8]. It is crucial to know the bone length in the different peri-orbital regions. The actual indication for placing the implants and the length that they should have derives from this information. Regions with a greater length allow for the use of longer implants, and the greater the length of the implant, the greater the success rate[9].

Planning the installation of osseointegrated implants requires the use of computed tomography (CT) to determine the preferential bone sites to install the implants, as they are highly predictable and reliable in the linear and volumetric quantification of the bone structure as well as in bone density evaluation[10-11]. CT scans in preoperative examinations to check the bone thickness at the recipient sites of implants have been widely indicated[10,12-13].

This study evaluated the length and width dimensions of the right and left peri-orbital bone, measured on CT scans, seeking to determine the more favorable peri-orbital bone areas for the installation of osseointegrated implants. The validation of the method was also performed, ensuring reliability and safeguard in its application in the planning of rehabilitation by means of osseointegrated implants.

Material and methods

This work used 30 dry adult human skulls of both genders and no age limitations obtained from the Department of Anatomy of the Health Sciences Center of the Federal University of Pernambuco, Brazil. Approval for the study was granted from the Ethics Committee of the School of Dentistry of the University of São Paulo, Brazil (Protocol # 187/03).

With the help of reduced copies of a 4-cm-diameter protractor cut and pasted to a white cardboard and placed at every 30 degrees in both orbits of each skull, a clock and number of hours was prepared. The 12 h point corresponded to 90º, 3 h to 0º, 6 h to 270º and 9 h to 180º. In each orbit, the 12 sites that corresponded to the hours of a clock were demarcated, so that point 3 h in the right orbit was always coincident with point 9 h in the left orbit (Figure 1).

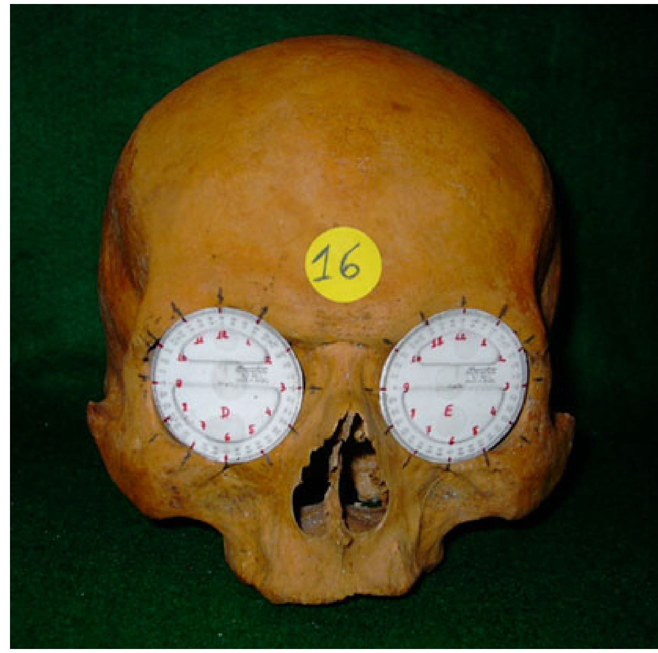

Fig. 1 - Adapted locator in the orbits. Points of reference coinciding with the hours of a clock.

For the CT recording, repair points were set, using a copper wire of 1 mm in diameter and 1 mm in length (Figure 2 A and B).

The skulls were placed on the ELSCINT SeleCT-SP Compact spiral CT system (Elscint, Haifa, Israel) and a low-power laser (645-660 nm wavelength) was applied to assure the right position of the skull on the CT table - its red light was coincident with the coronal and sagittal sutures of the skull to be studied. In the Workstation, the image protocol was: Software DentCT; coronal cut; thickness of cut: 1.5 mm; increment: 1.0 mm; pitch: 1.0 mm; gantry angulation: 0º. The software was applied to the peri-orbital rim, producing transversal images, obtaining 60 reconstructions. The radiopaque images of the previously established 12 points of repair were recorded on a scale (Figure 2C).

From the images in the coronal sections of each CT, 2

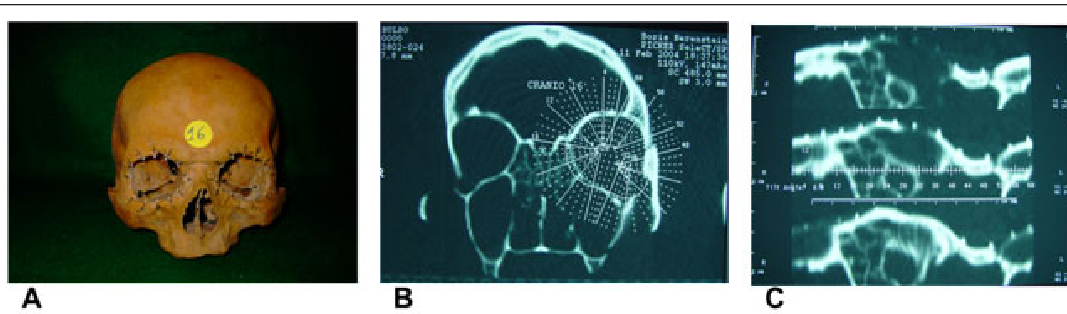

Fig. 2 - Skull and computed tomography scan of the left orbit. A - Skull with the demarcated right and left peri-orbital regions; radiopaque points determined in accordance with the marking provided by the locator; - B - location and delineation of the anatomical points; C - scale showing the sequence of reconstructions (from 1 to 60) with the respective correspondence of the radiopaque images of the repair points fixed in each skull.

films were obtained for each orbit. The scale covered a range of all the reconstructions, with the images of the peri-orbital regions arranged from point 12 h to 1 h (Figure 3A-D). However, for a correlation of the anatomical areas in the left and right orbits, the transverse section sequence of cuts was set reverse or anticlockwise to the right orbit.

The delineations were designed corresponding to the length (longitudinal direction in relation to the radiopaque image of the repair section) and the width (perpendicular direction to the longitudinal delineation length).

The evaluation of the left orbits began with the 12 h point, and followed a clockwise direction, while the analysis sequence for the right orbits, also starting at the 12 h point was reversed, in other words, following the anticlockwise direction. In the 7 h, 8 h, 9 h, 10 h and 11 h points, only the measures of length were performed, because the width ones did not have their limits precisely accurate. No measurements were made on point 6, because the region where it was located was close to the infra-orbital foramen, which is of no interest for implant placement. The regions of points 7 h to 11 h and points from 1 h to 5 h, corresponding to the medial wall of the left and right orbits, in which the relative width values were not recorded due to the lack of precision of the CT limits in the transverse cutting section, showed large width dimensions. We therefore consider that the width of this region does not pose any problem for osseointegrated implants.

The length and width linear measurements of each point were performed by two previously calibrated examiners, following a time interval of at least 7 days between the first and second measurement, both for examiner 1 and examiner 2. Both CT scans of each orbit were placed on a light box of 1m x 1m, where it was possible to observe the location and delimitation of the anatomical points defined in this study. In each CT image there was a scale corresponding to the cuts made, where the radiopaque images of the 12 previously set repair points were verified. Sixty cuts were recorded. The cross section cut to be evaluated was defined by the coincidence of the point of repair with the sequential numbering established in the scale constant in the CT. After defining the cross-section cut, a transparency was placed on the CT using a transparent adhesive tape. Then, the tracings corresponding to the length (longitudinal direction in relation to the radiopaque image of the repair point) and width (perpendicular to the longitudinal tracing of the length) were drawn. Each measurement was performed using a needle-point compass; the first measurement performed was the length, and the second one was the width. A database consisting of 120 spreadsheets was prepared, with the data obtained by the two examiners, in addition to the two measurements performed by each examiner.

Data were analyzed by descriptive statistics and the paired Student's t-test was used as inferential technique. The software used to obtain the statistical calculations was SAS version 8 (Statistical Analysis System; SAS Inc., Cary, NC, USA). The significance level was set at 5%.

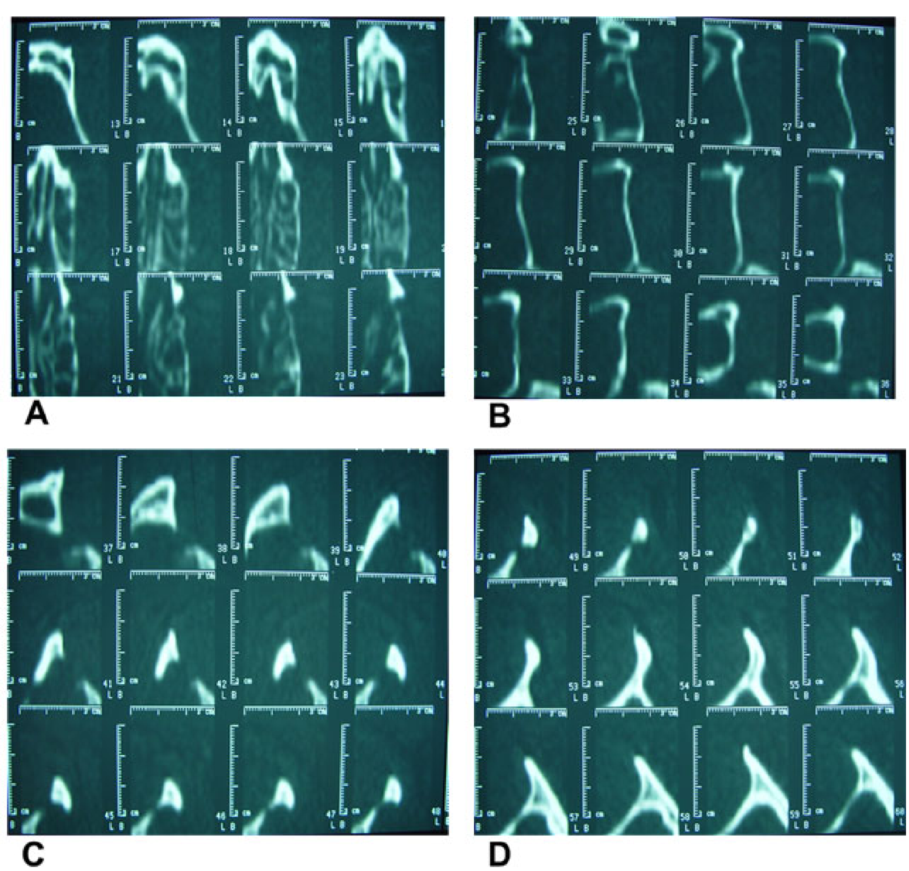

Fig. 3 - Computed tomography scan of the left orbit. Images corresponding to the cross-sectional cuts of the peri-orbital. A - cuts 13 to 24 B; - cuts 25 to 36; C - cuts 37 to 48 D; - cuts 48 to 60.

Results

The results are presented in Tables 1 to 5.

Considering the values for the length of the left peri-orbital, it was found that the highest averages were recorded at the point corresponding to 1 h, and the lowest at the point corresponding to 10 h, for both examiners and both measurements. The averages of the length measurements obtained in points corresponding to 12 h, 2 h, 3 h, 4h and 5h were higher than those found in points 7 h, 8 h, 9 h, 10 h and 11 h. Overall, no significant intra-examiner differences were observed, as well as inter-examiners in the first measurement, although significant inter-examiner differences occurred at the 5% level in the second measurement (Table 1).

The highest averages regarding the width of the left peri-orbital bone occurred in point 12 h, and the lowest in point 2 h, with points 1 h, 3 h, 4h and 5h showing intermediate values. Intra-examiner differences were only recorded in points 4h and 5 h, for examiner 1. There were significant inter-examiner differences in points 12 h, 4h and 5 h, in general, for the 1st measurement. Overall, significant differences were found at level 5%, between the 1st and 2nd

Table 1. Measurements in millimeters and standard deviation of the length of the left peri-orbital bone according to the measurement site, measurement, and examiner.

		Examiner		
Section	**Measure**	**1**	**2**	**Value of p (1)**
		Average ± DP (1)	**Average ± DP**	
12 h	First	11.18 ± 5.12	11.40 ± 5.11	p = 0.2554
	Second	11.53 ± 5.16	11.38 ± 4.87	p = 0.3194
Value of p		p = 0.1007	p = 0.9422	
1 h	First	18.63 ±5.48	17.92 ±5.08	p = 0.0003*
	Second	18.70 ± 5.45	18.03 ± 5.14	p =0.0007*
Value of p		p = 0.6871	p = 0.5487	
2 h	First	13.33 ±4.62	12.97 ± 4.65	p = 0.0205*
	Second	13.05 ± 4.44	12.83 ±4.35	p = 0.1411
Value of p		p = 0.0354*	p = 0.5228	
3 h	First	9.28 ± 2.20	9.18 ± 1.99	p = 0.5407
	Second	9.20 ± 2.10	8.97 ± 1.97	p = 0.0698
Value of p		p = 0.6163	p = 0.0850	
4 h	First	9.30 ± 2.78	9.23 ± 2.59	p = 0.7238
	Second	9.43 ± 2.93	9.28 ± 2.97	p = 0.3795
Value of p		p = 0.5171	p = 0.7709	
5 h	First	9.13 ± 4.64	8.95 ± 4.79	p = 0.2031
	Second	9.43 ± 4.80	9.23 ± 4.81	p = 0.0563
Value of p		p = 0.0592	p = 0.0168*	
6h	-	-	-	
7 h	First	3.45 ± 1.33	3.57 ± 1.26	p = 0.4773
	Second	3.47 ± 1.36	3.65 ± 1.12	p = 0.1176
Value of p		p = 0.8790	p = 0.5015	
8 h	First	3.83 ± 1.06	3.98 ± 1.15	p = 0.0951
	Second	3.83 ± 1.26	4.05 ± 1.22	p = 0.1192
Value of p		p = 1.0000	p = 0.5362	
9 h	First	3.97 ± 0.96	3.95 ± 0.98	p = 0.9038
	Second	3.80 ± 1.13	3.87 ± 0.98	p = 0.5803
Value of p		p = 0.2383	p = 0.5618	
10 h	First	3.30 ± 1.06	3.27 ± 0.74	p = 0.7450
	Second	3.18 ± 1.02	3.13 ± 0.83	p = 0.6300
Value of p		p = 0.0897	p = 0.2228	
11 h	First	4.27 ± 2.46	4.32 ± 2.65	p = 0.7354
	Second	4.17 ± 2.75	4.25 ± 2.68	p = 0.3619
Value of p		p = 0.3389	p = 0.5256	
General	**First**	8.15 ± 5.77	8.07 ± 5.58	p = 0.0673
	Second	8.16 ± 5.83	8.06 ± 5.58	p = 0.0143*
Value of p		p = 0.8123	p = 0.9212	

(*) – Significant difference at 5.0% level.
(1) – Paired Student's- t-test.

Table 2. Measurements in millimeters and standard deviation of the width measurements of the left peri-orbital bone according to the measurement site, measurement, and examiner.

		Examiner		
Section	**Measure**	**1**	**2**	**Value of p (1)**
		Average ± DP	**Average ± DP**	
12 h	First	8.18 ± 2.77	8.50 ± 2.64	p = 0.0234*
	Second	8.60 ± 2.62	8.63 ± 2.54	p = 0.8252
Value of p		p = 0.0929	p = 0.6183	
1 h	First	6.83 ± 2.29	6.97 ± 2.30	p = 0.2927
	Second	7.02 ± 1.97	7.23 ± 2.22	p =0.2054
Value of p		p = 0.3665	p = 0.2329	
2 h	First	6.03 ± 1.58	5.92 ± 1.54	p = 0.3791
	Second	6.15 ± 1.54	6.08 ± 1.72	p = 0.6839
Value of p		p = 0.4282	p = 0.3305	
3 h	First	7.22 ± 1.79	7.27 ± 1.87	p = 0.6875
	Second	7.30 ± 1.55	7.23 ± 1.55	p = 0.6139
Value of p		p = 0.5776	p = 0.8881	
4 h	First	7.08 ± 1.88	7.30 ± 1.97	p = 0.0509*
	Second	7.47 ± 2.13	7.58 ± 2.08	p = 0.3944
Value of p		p = 0.0193*	p = 0.1432	
5 h	First	7.03 ± 2.33	7.40 ± 2.38	p = 0.0063*
	Second	7.38 ± 2.32	7.50 ± 2.10	p = 0.4954
Value of p		p = 0.0421*	p = 0.6675	
General	**First**	7.06 ± 2.21	7.32 ± 2.16	p = 0.0040*
	Second	7.21 ± 2.26	7.38 ± 2.18	p = 0.3486
Value of p		p = 0.0005*	p = 0.0729	

(*) – Significant difference at 5.0% level.
(1) – Paired Student's-t test.

measurement for examiner 1 and inter-examiners during the 1st measurement (Table 2).

With regard to the length of the right peri-orbital, the highest mean occurred in the point corresponding to 11 h, and the lowest in point 2h. Except for point 10 h, there was no statistically significant intra-examiner difference. However, there were significant inter-examiner differences ($p<0.05$) for both measurements in points 11 h, 3 h and 1 h, and in the second measurement in the points corresponding to 9 h, 8 h, 5 h and 4 h. In general, there was a significant intra-examiner difference at 5% level for both examiners, but there is no statistical significance in the inter-examiner variation for both measurements (Table 3).

For the width of the right peri-orbital, the highest mean values were observed for the evaluations of point 8 h, and the lowest for the evaluation of point 10 h. There were statistically significant intraexaminer differences ($p<0.05$) in the measurement of points 12 h and 8 h, and in the overall average for both examiners. In the inter-examiner variation, there was a significant difference ($p<0.05$) in both measurements in point 12 h, in the 1st measurement of point 9 h, and in the 2nd measurement of point 8 h. Considering the general values, there were also significant inter-examiner differences($p<0.05$) in both 1st and the 2nd measurements (Table 4).

In this work, the greatest bone length was observed in the points corresponding to 1h (18.32 mm) - 11h (19.28 mm), with an average of 18.80 mm, considering the left and right orbits, respectively. For the left orbit, the points 2 h and 12 h, which had an average of 13.05 mm and 11.37 mm, respectively, the same anatomical sequence was observed for the right orbit, with values of 12.34 mm and 11.56 mm, respectively (Table 5).

Discussion

Few works have been conducted to verify the length and thickness measurement of facial regions, focusing on the installation of implant-supported facial prostheses[2,14-18]. Jensen et al.[15] (1992) assessed the available bone volume in 16 places of the skull-facial skeleton of 15 human skulls using a caliper in two places in the supra-orbital rim; 2 in the lateral margin of the orbit, and 1 on the infra-orbital edge, showed that the mean bone length in these places were of 4.4 mm and 4.6 mm; 5.9 mm and 6.1 mm; and 5.4 mm, respectively. In the study of Klein et al.[10] (1997), the use of CT scan indicated the following values: medial infra-orbital: 2 mm; lateral infra-orbital: 6 mm; medial supra-orbital: 3 mm; lateral supra-orbital: 8 mm; medial region of the orbit:

Table 3. Measurements in millimeters and standard deviation of the length of the right peri-orbital bone according to the measurement site, measurement, and examiner.

		Examiner		
Section	Measure	1	2	Value of p (1)
		Average ± DP	Average ± DP	
12 h	First	11.75 ± 4.99	11.55 ± 5.27	p = 0.1668
	Second	11.57 ± 5.09	11.37 ± 5.02	p = 0.1953
Value of p		p = 0.1254	p = 0.2156	
11 h	First	19.50 ± 3.95	19.08 ± 3.70	p = 0.0086*
	Second	19.50 ± 3.81	19.03 ± 3.92	p =0.0100*
Value of p		p = 1.0000	p = 0.8260	
10 h	First	12.65 ±4.94	12.45 ± 4.57	p = 0.3514
	Second	12.30 ± 4.81	11.97 ±4.51	p = 0.0503
Value of p		p = 0.0101*	p = 0.0094*	
9 h	First	8.70 ± 2.00	8.60 ± 1.93	p = 0.3854
	Second	8.72 ± 1.76	8.40 ± 1.81	p = 0.0234*
Value of p		p = 0.9038	p = 0.2061	
8 h	First	10.43 ± 3.12	10.17 ± 3.11	p = 0.1219
	Second	10.35 ± 2.98	9.82 ± 2.78	p = 0.0022*
Value of p		p = 0.6460	p = 0.1007	
7 h	First	8.62 ± 4.75	8.68 ±4.54	p = 0.6453
	Second	8.77 ± 4.75	8.52 ± 4.49	p = 0.1694
Value of p		p = 0.2221	p = 0.3781	
6h	-	-	-	
5 h	First	3.90 ± 1.33	3.88 ±1.38	p = 0.8973
	Second	3.82 ± 1.41	4.10 ± 1.40	p = 0.0168*
Value of p		p = 0.4844	p = 0.0677	
4 h	First	3.45 ± 0.72	3.63 ± 0.67	p = 0.0777
	Second	3.38 ± 0.67	3.62 ± 0.60	p = 0.0457*
Value of p		p = 0.5803	p = 0.8759	
3 h	First	3.90 ± 1.00	4.22 ± 1.20	p = 0.0234*
	Second	3.75 ± 1.06	4.08 ± 1.16	p = 0.0245*
Value of p		p = 0.2638	p = 0.3974	
2 h	First	3.25 ± 0.97	3.32 ± 0.79	p = 0.6078
	Second	3.07 ± 1.05	3.18 ± 0.70	p = 0.3791
Value of p		p = 0.0858	p = 0.1033	
1 h	First	3.52 ± 1.98	3.83 ± 1.84	p = 0.0277*
	Second	3.45 ± 1.84	3.77 ± 1.68	p = 0.0046*
Value of p		p = 0.5642	p = 0.5362	
General	**First**	8.15 ± 5.86	8.13 ± 5.66	p = 0.6095
	Second	8.06 ± 5.84	7.95 ± 5.52	p = 0.0504
Value of p		p = 0.0212*	p = 0.0018*	

(*) – Significant difference at 5.0% level.
(1) – Paired Student's- t-test.

2 mm; side of the orbit: 10 mm. Olate et al.[14] (2011) measured the peri-orbital bone region of 40 dry skulls, using the data obtained from cone beam CTs virtually reconstructed. The authors divided the orbit in superior and inferior, and each one in lateral, intermediary and medial regions. The thickness data verified, for the superior orbit, were: lateral region:7.5 mm, intermediary region: 8.31 mm, medial region: 9.23 mm. For the inferior orbit, the obtained data were: lateral region: 7.62 mm, intermediary region: 6.51 mm, medial region: 6.11 mm.

Studies comparing linear or volumetric measures of craniometrical sections using CT, and performing manual measures in dry skulls, cadaverous heads, including imaging data of patients, showed no statistically significant differences between the manual direct measurement method and the method that uses CTs[19-21].

In this study, the greatest bone lengths were observed in the points corresponding to 1 h (18.32 mm), for the left orbit, and to 11 h (19.28 mm), for the right orbit, with a mean value of 18.80 mm. These findings are compatible with those of Matsuura et al.[16] (2002), who also found the greatest lengths in the point 1 h, with mean value of 16.00 mm. For the left orbit, the second and third major lengths found in this study were verified in the points 2 h and 12 h, which showed 13.05 mm and 11.37 mm, respectively. The same anatomical sequence was observed for the right orbit, with values of 12.34 mm and 11.56 mm, respectively. In the present work,

Table 4. Measurements in millimeters and standard deviation of the width of the right peri-orbital bone according to the measurement site, measurement, and examiner.

		Examiner		
Section	Measure	1	2	Value of p (1)
		Average ± DP	Average ± DP	
12 h	First	7.33 ± 2.29	7.62 ± 2.33	p = 0.0125*
	Second	7.82 ± 2.20	8.20 ± 2.33	p = 0.0032*
Value of p		p = 0.0056*	p = 0.0169*	
11 h	First	6.97 ± 2.09	7.10 ± 2.04	p = 0.4591
	Second	7.23 ± 1.60	7.47 ± 1.77	p =0.1334
Value of p		p = 0.2142	p = 0.0617	
10 h	First	5.88 ± 1.42	5.83 ± 1.51	p = 0.6757
	Second	6.02 ± 1.37	6.10 ± 1.52	p = 0.5378
Value of p		p = 0.2838	p = 0.1256	
9 h	First	6.93 ± 1.36	7.22 ± 1.30	p = 0.0072*
	Second	7.15 ± 1.35	7.38 ± 1.23	p = 0.0947
Value of p		p = 0.1671	p = 0.3305	
8 h	First	7.73 ± 2.22	7.85 ± 2.30	p = 0.3791
	Second	8.27 ± 2.17	8.77 ± 2.27	p = 0.0016*
Value of p		p = 0.0067*	p = 0.0001*	
7 h	First	6.77 ± 2.39	7.03 ± 2.33	p = 0.1105
	Second	6.97 ± 2.27	7.07 ± 2.10	p = 0.6338
Value of p		p = 0.3115	p = 0.9045	
General	**First**	6.94 ± 2.06	7.09 ± 2.11	p = 0.0065*
	Second	7.24 ± 1.97	7.50 ± 2.07	p < 0.0001*
Value of p		p < 0.0001*	p < 0.0001*	

(*) – Significant difference at 5.0% level.
(1) – Paired Student's- t-test.

Table 5. Measurements of length and width of the right and left peri-orbital bone

Sections	Left Peri-orbital bone		Right Peri-orbital bone		Average	
	Length	Width	Length	Width	Length	Width
12 h – 12 h	11.37	8.48	11.56	7.74	11.47	8.11
1 h – 11 h	18.32	7.01	19.28	7.19	18.80	7.10
2 h – 10 h	13.05	6.05	12.34	5.96	12.70	6.01
3 h – 9 h	9.16	7.25	8.60	7.17	8.88	7.21
4 h – 8 h	9.31	7.36	10.19	8.15	9.75	7.75
5 h – 7 h	9.19	7.32	8.64	6.96	8.92	7.14
6 h – 6 h	-	-	-	-	-	-
7 h – 5 h	3.53	-	3.22	-	3.38	-
8 h – 4 h	3.92	-	3.52	-	3.72	-
9 h – 3 h	3.90	-	3.99	-	3.94	-
10 h – 2 h	3.22	-	3.20	-	3.21	-
11 h – 1 h	4.25	-	3.64	-	3.95	-

* Means in millimeters

point 12 h presented one of the greatest lengths, what corroborates with the findings of Matsuura et al.[16] (2002), that employed cadaveric heads in their study. Thus, it is observed that the three points with the greatest lengths are located in the supra-orbital rim, which is also substantiated by Matsuura et al.[16] (2002). Olate et al.[14] (2011) found the greatest thickness in the medial region of the superior orbit – 9.23 mm.

The shift towards the side wall of the orbit, which corresponds to points 3 h-9 h, 4 h-8 h and 5 h-7 h, in the left and right orbits, shows mean values of 8.88 mm, 9, 70 mm and 8.92 mm, respectively. Although lower, these mean values are compatible with the use of intraoral osseointegrated implants. These points correspond to the lateral and infralateral wall of the orbit. It is important to consider that longer intraoral implants have been used in the orbital region to support orbital prosthesis[1,22]. In the same way as in the present study, Klein et al.[10] (1997) found that the points with the greatest length are located in the lateral-top and orbit lateral regions.

The lowest values reported by Jensen et al.[15] (1992) for the supra-orbital rim lengths (4.4 mm and 4.6 mm) and the lateral wall of the orbit (5.4 mm, 5.9 mm and 6.1 mm) are probably due to the methodology used by those authors (they measured directly the skull using a caliper, while the measurements performed in the present work were made in CTs).

A large variability in the bone depth around the frontal zygomatic suture has been reported[18]. Reher and Duarte [17] (1994), concerned with the appearance of the bone depth, recommend the use of 5-mm and 7-mm-long screws, in mini osteosynthesis plates, above and below the frontal zygomatic suture.

This region, which is located on the lateral wall of the orbit, in this paper, show consistent mean values using 7-mm-long osseointegrated implants. The point with the lowest length was coincident in both orbits, corresponding to 10 h – 2 h and presenting values of 3.22 mm and 3.20 mm, respectively. These findings are close to those of Matsuura et al.[10] (2002), who found the lowest bone length (3.0 mm) for point 10 h, as well as those of Klein et al.[10] (1997) for the medial infra orbital region. With less bone depth, this region represents a less important area in the planning of rehabilitating implant-supported prosthetics in ocular-palpebral prosthesis. In cases of extreme need, this region must receive lesser-length osseointegrated implants.

With regard to the width, the points with the greatest values were not coincident between the orbits, corresponding to 12 h for the left orbit (8.48 mm) and 8 h for the right orbit (8.15 mm). However, the immediate inferior values are located in the same correspondent points for the left and right orbits - the left orbit showed a mean of 7.36 mm at 4 h (point corresponding to the 8 h point in the right orbit), and the right orbit, a mean of 7.74 mm at 12h. Generally, the mean width in point 12 h was of 8.11 mm, greater than those presented by points 4 h and 8 h (7.75 mm). These points correspond to the supra-orbital edge and to the lateral inferior region of the orbit, which as a result of these measurements do not constitute risk locations for the placement of osseointegrated implants. In this work, the width values ranged from 5.96 mm to 8.48 mm, with the lowest values for points 2h (6.05) and 10 h (5.96 mm). Matsuura et al.[16] (2002) reported values that ranged from 6.8 mm to 11.1 mm, with the lowest value for point 2 h (6.8 mm). The variation of the orbital margin width in this work (3.52 mm) is lower than that reported by Matsuura et al.[16] (2002) (4.3 mm) and Klein et al.[10] (1997) (5 mm).

The regions of points 7 h to 11 h and points 1 h to 5 h, corresponding to the medial walls of the left and right orbits, for which no width values were recorded due to the lack of accuracy on the CT limits in cross-section cut, showed large width dimensions. Thus, we believe that the width of this region does not pose any difficulty for indicating osseointegrated implants.

The intra- and inter-examiner reading differences in Tables 1-4, it appears that, considering a significant difference at the level of 5.0%, there were few differences, given the readings made. These results indicate good accuracy in the data readings between both measurements or between both examiners.

We assume that the importance of CT in verifying the bone measurements is indisputable, in light of craniofacial implant placement. The measurement method of peri-orbital regions in CT, proposed in this study, is valid and can be clinically used in the planning of osseointegrated implants in the peri-orbital region.

It is essential that the mean values observed in this work are not seen as determinant in defining the length of the implant to be used. The absolute values should serve only as an indication of the bone receptor sites that are more favorable to the installation of osseointegrated implants, keeping in mind the individuality of each patient. The planning of implant-retained prosthetics rehabilitation in the cranial-facial region requires the implementation of CTs in all cases, the reason for assessing this method, hence providing information to help in the planning of prosthetic surgery.

The determination of the sites depends not only on the bone conditions of the receptor site of the implants, but also on the prosthetic planning, keeping in mind that prosthetic rehabilitation is ultimately the greater goal for the treatment proposed. Only the perfect integration of a multidisciplinary team enables the development of a successful rehabilitation process, which is ultimately reflected in safeguarding our patients' quality of life.

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