นิพนธ์ต้นฉบับ **Original Article**

ความสัมพันธ์ระหว่างความหนาของกะโหลกศีรษะที่วัดโดยตรงด้วยเครื่องวัดกับที่วัดโดยภาพถ่ายรังสีของกะโหลกศีรษะสามมิติ

Calvarial Thickness and Its Correlation to Three-Dimensional CT (3D-CT) Scan

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บทคัดย่อ

การศึกษาเชิงพรรณนาเพื่อวัดความหนาของกะโหลกศีรษะที่วัดโดยตรงด้วยเครื่องวัด ตรงส่วน parietal bone ในคนไทย และหาความสัมพันธ์กับที่วัดโดยภาพถ่ายรังสีของกะโหลกศีรษะสามมิติ ทำการศึกษาในศพทั้งหมด 65 ราย (เพศชาย 34 ราย และเพศหญิง 31 ราย) โดยทำการวัดใน 9 ตำแหน่งของกะโหลกศีรษะแต่ละข้าง โดยใช้เครื่องวัด Depth micrometer series 128-101 และเครื่องถ่ายภาพรังสีของกะโหลกศีรษะสามมิติ GE lightspeed VCT 64 scanner จากผลการศึกษา พบว่าค่าความหนาเฉลี่ยของกะโหลกศีรษะส่วน parietal bone ทุกบริเวณเท่ากับ 6.68 ± 1.94 มม. และที่ตำแหน่งหมายเลข 5 พบว่าค่าความหนาเฉลี่ยที่วัดโดยเครื่องวัด micrometer เท่ากับ 7.13 ± 2.28 มม. ส่วนที่วัด

จากภาพถ่ายรังสีของกะโหลกศีรษะสามมิติ เท่ากับ 7.00 ± 2.22 มม. ทำให้มีความแตกต่างเฉลี่ย เท่ากับ 0.13 มม. ซึ่งมีความสำคัญทางสถิติ แต่ไม่มีความสำคัญทางคลินิก และจากการหาความสัมพันธ์ระหว่างค่าความหนาจากการวัดทั้งสองวิธีสามารถเขียนในรูปสมการได้ดังนี้ micrometer = 0.025 + 1.025 (3D-CT) ซึ่งสรุปได้ว่า ค่าความหนาที่วัดโดยเครื่องวัดโดยตรงมีความสัมพันธ์เป็นอย่างดีกับค่าความหนาที่วัดจากภาพถ่ายรังสีของกะโหลกศีรษะสามมิติ

คำสำคัญ : ความหนาของกะโหลกศีรษะ, ความสัมพันธ์, ภาพถ่ายรังสีของกะโหลกศีรษะสามมิติ

ABSTRACT

This is a descriptive study that measure the thickness of parietal bone in Thai adult cadavers and find out its correlation to three-dimensional CT scan. A total of 65 (male 34 and female 31) cadaveric skulls were used in this study. The calvarial thickness is measured in 9 points on each parietal area of skull by Depth micrometer series 128-101 (Mitutoyo Corporation, Kanagawa, Japan). The three-dimensional CT scans were made on a GE lightspeed VCT 64 scanner (General Electrics Medical System, Milwaukee, Wisconsin). Mean thickness of all parietal bones was 6.68 ± 1.94 mm (0.84-15.59 mm). At point 5, mean thickness measured by micrometer was 7.13 ± 2.28 mm and 7.00 ± 2.22 mm with three-dimensional CT scan, respectively. Mean difference was 0.13 mm that statistically significant *(p-value < 0.01)* but the upper limit of 95% confidence interval of all difference was only 0.28 mm that not clinically significant. The relationship between the two measurement modalities could had equation of relationship as micrometer = 0.025 + 1.025 (3D-CT). The study concluded that agreement between the micrometer and three-dimensional CT measurements was acceptable.

Keyword : Calvarial Thickness, Correlation, Three-Dimensional CT (3D-CT) Scan

Background

The skull is a frequent site of bone graft harvest in reconstructive plastic surgery.[1-12] The superiority of this site over other donor sites has been documented both clinically and experimentally.[1-4,8-10] It is easily accessed during craniofacial reconstruction and because of its proximity to the surgical field, large amounts of bone can be harvested at one sitting ; also, the donor site is relatively painless.[1-3] Because of its dense cortical structure, it undergoes less resorption than other bone graft sites and the morbidity related to cranial bone graft harvest reported in the literature is very low.[4-6,9-10,12-13] Although complications are infrequent, these complications can be significant. Serious neurologic sequelae after skull bone harvest have been reported.[5,14-16]

Therefore, a detailed knowledge of skull thickness, its variability from patient to patient and from location to location and its variation among various ethnic groups are of import to the operating surgeon. From this information, it is possible that bone graft harvest complications might be reduced.

As early as 1882, Anderson[17] reported on calvarial bone thickness in 154 Irish cadavers which was followed by a report by Todd[18] in 1924 with an account on 448 adult white males. Thereafter, Roche[19] and Adeloye[20] studied the regional thickness of the calvaria and the thickness differences according to age, sex and race using skull roentgenography. Pensler & McCarthy[21] and Sullivan & Smith[22] reported upon an anatomical study of regional thickness in cadavers but the measurement points were limited. A recent study of parietal bone thickness by Koenig et al.[23] was performed by CT scan. However, anatomical reports upon calvarial bone graft in Asians are very rare.

There are some studies from Japan[24] and Korea[25-27] report about calvarial bone thickness but no studies in Asians that correlated between direct measurement of calvarial thickness and three-dimensional CT scan.

The best donor site has been believed to be 2 cm posterior to the coronal suture in the parietal bone[28] and the area lateral to the sagittal sinus, which is at least 1.5 cm lateral from the sagittal suture on either side to avoid potential injury to the sagittal sinus.[29]

This is the descriptive study that undertaken to measure the thickness of parietal bone as a potential calvarial donor site in Thai adult cadavers as a guide to harvesting calvarial bone and find out its correlation to three-dimensional CT scan.

Materials and Methods

Inclusion criteria : Adult cadaveric skulls (more than 20 years) in the Department of Anatomy, Siriraj Hospital.

Exclusion criteria : Adult cadaver who the cause of death is correlated to head injury or has skull defect.

Measurement methods : Parietal bone was chosen as the focus of this study because the posterior part of the parietal bone is the most preferred cranial bone-graft donor site. A total of 65 (male 34 and female 31) cadaveric skulls were used in this study.

The calvarial thickness is measured in 9 points on each parietal area of skull (9 points on right parietal area and 9 points on left parietal area).

9 points on each parietal area are located at the intersection of the longitudinal and transverse lines described below (Fig. 1)

- The sagittal suture was outlined as the midline from which all longitudinal (anteroposterior) lines were defined.
- Longitudinal lines were outlined parallel to and at 1.5, 4.5, 7.5 cm intervals from the midline (L1, L2, L3 at 1.5 cm, L4, L5, L6 at 4.5 cm, L7, L8, L9 at 7.5 cm on the left side from the midline and R1, R2, R3 at 1.5 cm, R4, R5, R6 at 4.5 cm, R7, R8, R9 at 7.5 cm on the right side from the midline).
- Transverse lines were determined using the coronal sutures as landmarks and 2.0, 6.0, 10.0 cm intervals from the coronal sutures (L1, L4, L7 at 2.0 cm, L2, L5, L8 at 6.0 cm, L3, L6, L9 at 10.0 cm on the left side and R1, R4, R7 at 2.0 cm, R2, R5, R8 at 6.0 cm, R3, R6, R9 at 10.0 cm on the right side).

The thickness was measured and recorded in the unit of mm by Depth micrometer series 128-

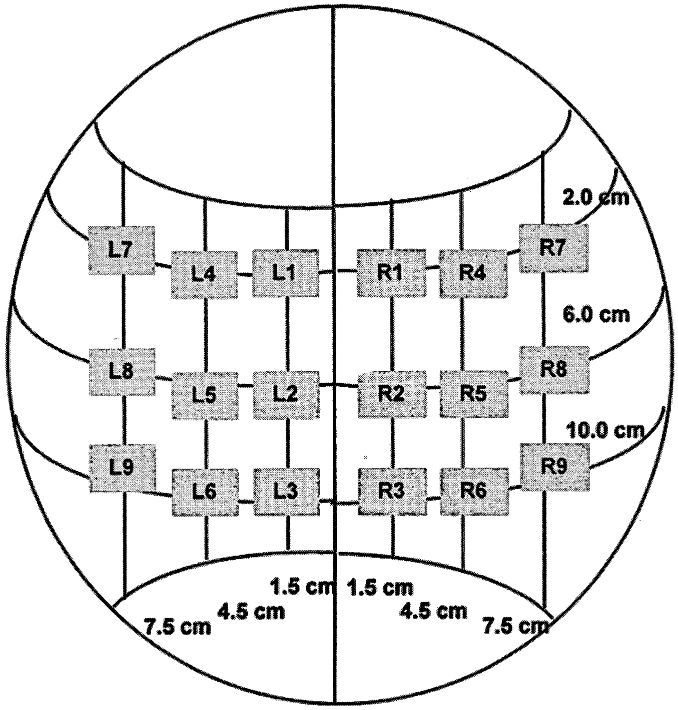


Fig. 1 The points at which cranial thickness was measured were determined in 9 points for each side of the skulls.

101 (Mitutoyo Corporation, Kanagawa, Japan).

Three-dimensional CT scan : The scans were made on a GE lightspeed VCT 64 scanner (General Electrics Medical System, Milwaukee, Wisconsin). Direct coronal 0.625 mm thick sections were obtained in all parietal bones with this multislice detector CT scanner. Slice thickness was determined as 0.625 mm at 120 kV and 150 mA ; the field of view was 380 mm. Measurements were done on the three dimensional reconstruction images on the computer screen by the Volume Viewer Plus Voxtool 5.8.0 software at L5 and R5 points and recorded in unit of mm (Fig. 2A-2F).

Statistical methods : In order to see how well the micrometer and CT measurements agreed, differences between two methods (Micrometer - CT) were plotted against the average of the two measurements and 95% confidence interval (CI) were calculated. For a method comparison study, mean ± SD was taken as a 95% confidence interval for individuals. This range of values was defined as the 95% confidence interval. The agreement between the micrometer and CT measurements was assessed by using the intraclass correlation and Bland & Altman approach.[30] The equation of relationship was used in regression analysis. The software that used to calculate in this study was nQuery Advisor (version 3.0), SPSS (version 10.0), MedCalc (trial version) software.

Results

The demographic data was shown in table 1.

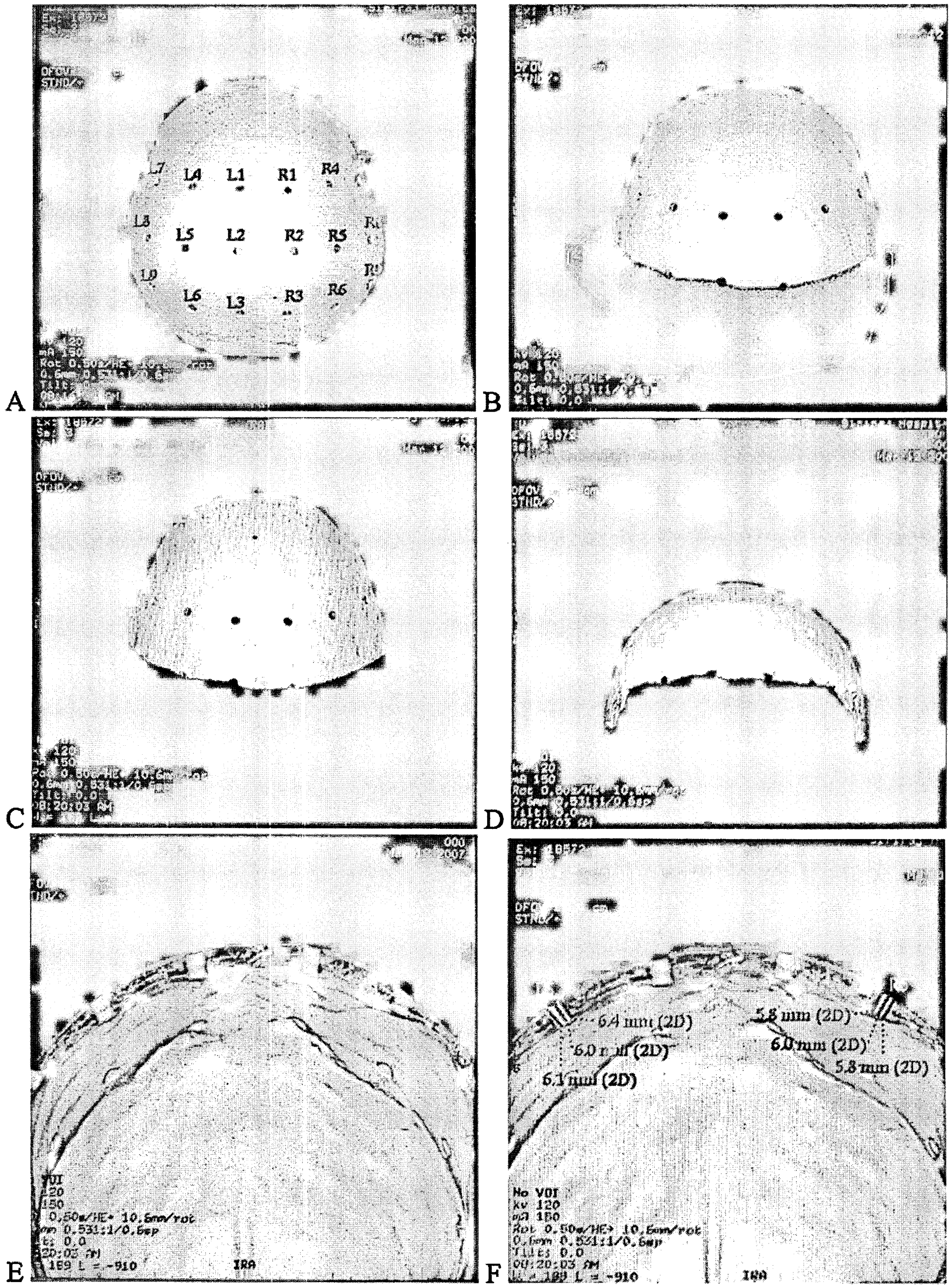


Fig. 2A-2F : (A) The three dimensional reconstruction image ; (B) The image was cut by using the Volume Viewer Plus Voxtool 5.8.0 software ; (C) The image after cut the posterior part ; (D) The image was rotated around transverse Axis ; (E) The image was magnified and ready for measurement ; (F) The thickness was measured at L5 and R5 points.

Table 1 The demographic data of the mean age

Sex	n (skulls)	Age (years) Mean ± SD
Female	n = 31	67.7 ± 15.7
Male	n = 34	67.9 ± 14.2
Total	n= 65	*p-value* = 0.96

There were totally 65 skulls in this study divided as 31 skulls in the female group and 34 skulls in the male group.

The mean age of the female and male group was 67.7 ± 15.7 and 67.9 ± 14.2 years respectively, that was not statistically significant *(p-value = 0.96)*.

The calvarial thickness measured by micrometer :

The mean thickness of the parietal bone at L1-9 and R1-9 measured by micrometer were shown in table 2.

The mean thickness of the parietal bone was 6.68 ± 1.94 mm.

The thickness of the parietal bone varied from 0.84 mm to 15.59 mm.

The mean thinnest part of the both parietal bones was point 1 (mean thickness 5.79 ± 1.73 mm).

The mean thickest part of the both parietal bones was point 2 (mean thickness 7.40 ± 2.11 mm).

The difference and correlation of the left side and the right side were shown in table 3.

Table 2 The calvarial thickness measured by micrometer (the left side, the right side and total)

	Left (n = 65)		**Right (n = 65)**		**Total (n = 130)**	
	Mean ± SD	**Min - Max**	**Mean ± SD**	**Min - Max**	**Mean ± SD**	**Min - Max**
1	5.87 ± 1.81	2.60 - 10.40	5.70 ± 1.65	0.84 - 9.65	5.79 ± 1.73	0.84 - 10.40
2	7.39 ± 2.20	3.37 - 13.62	7.41 ± 2.05	3.72 - 13.25	7.40 ± 2.11	3.37 - 13.25
3	7.51 ± 1.66	4.01 - 12.64	7.22 ± 1.69	3.86 - 13.76	7.36 ± 1.67	3.86 - 13.76
4	6.45 ± 1.79	3.21 - 12.56	6.51 ± 1.70	3.86 - 10.93	6.48 ± 1.74	3.21 - 12.56
5	7.15 ± 2.41	3.23 - 13.58	7.04 ± 2.18	3.05 - 12.92	7.10 ± 2.29	3.05 - 13.58
6	7.13 ± 2.38	3.68 - 15.59	6.96 ± 2.13	3.50 - 15.42	7.04 ± 2.25	3.50 - 15.59
7	5.98 ± 1.59	2.66 - 11.08	6.20 ± 1.59	3.37 - 10.40	6.09 ± 1.59	2.66 - 11.08
8	6.61 ± 2.35	2.25 - 13.40	6.45 ± 2.08	2.89 - 13.38	6.53 ± 2.21	2.25 - 13.40
9	6.39 ± 2.04	2.30 - 11.97	6.36 ± 1.75	2.98 - 11.67	6.37 ± 1.90	2.30 - 11.67

Table 3 The difference and correlation of calvarial thickness measured by micrometer on the left side and the right side

	Left (n = 65)	Right (n = 65)	Difference (Lt - Rt)			Correlation (Lt & Rt)	
	Mean ± SD (mm)	Mean ± SD (mm)	Mean Difference (mm)	95% CI of Difference	*p-value*	r (Pearson correlation)	*p-value*
1	5.87 ± 1.81	5.70 ± 1.65	0.17	-0.08, 0.42	$p = 0.17$	0.84	$p < 0.01$
2	7.39 ± 2.20	7.41 ± 2.05	-0.02	-0.28, 0.25	$p = 0.91$	0.87	$p < 0.01$
3	7.51 ± 1.66	7.22 ± 1.69	0.29	0.09, 0.48	$p < 0.01$	0.89	$p < 0.01$
4	6.45 ± 1.79	6.51 ± 1.70	-0.06	-0.25, 0.14	$p = 0.57$	0.90	$p < 0.01$
5	7.15 ± 2.41	7.04 ± 2.18	0.11	-0.15, 0.36	$p = 0.40$	0.91	$p < 0.01$
6	7.13 ± 2.38	6.96 ± 2.13	0.17	-0.03, 0.37	$p = 0.10$	0.94	$p < 0.01$
7	5.98 ± 1.59	6.20 ± 1.59	-0.22	-0.43,-0.02	$p < 0.01$	0.87	$p < 0.01$
8	6.61 ± 2.35	6.45 ± 2.08	0.16	-0.10, 0.43	$p = 0.22$	0.90	$p < 0.01$
9	6.39 ± 2.04	6.36 ± 1.75	0.03	-0.17, 0.23	$p = 0.76$	0.92	$p < 0.01$

The almost difference of the left and right calvarial thickness was not statistically significant *(p-value > 0.05)*, except at point 3 and 7 that were statistically significant *(p-value < 0.01)* but the upper limit of 95% confidence interval of all difference was only 0.48 mm that not clinically significant.

There were correlation between calvarial thickness of the left side and the right side statistically significant (p-value < 0.01) at all points of L1-9 and R1-9.

The thickness of the parietal bone divided by gender was shown in table 4.

The mean thickness of the parietal bone was 6.68 ± 1.94 mm.

The thickness of the parietal bone in the female group varied from 0.84 mm to 15.59 mm.

The mean thinnest part in the female group was R1 (mean thickness 6.01 ± 1.83 mm).

The mean thickest part in the female group was L2 (mean thickness 8.40 ± 2.20 mm).

The thickness of the parietal bone in the male group varied from 2.60 mm to 11.05 mm.

The mean thinnest part in the male group was L7 (mean thickness 5.30 ± 1.29 mm).

The mean thickest part in the male group was L3 (mean thickness 7.11 ± 1.56 mm).

The thickness of the parietal bone in the both groups varied from 0.84 mm to 15.59 mm.

The mean thinnest part in the both groups was R1 (mean thickness 5.70 ± 1.65 mm).

Table 4 The calvarial thickness measured by micrometer (female, male and total)

	Female (n = 31)		Male (n = 34)		Total (n = 65)	
	Mean ± SD	Min - Max	Mean ± SD	Min - Max	Mean ± SD	Min - Max
L1	6.33 ± 2.06	3.04 - 10.40	5.45 ± 1.45	2.60 - 9.06	5.87 ± 1.81	2.60 - 10.40
L2	8.40 ± 2.20	5.27 - 13.62	6.48 ± 1.77	3.37 - 9.82	7.39 ± 2.20	3.37 - 13.62
L3	7.94 ± 1.67	5.55 - 12.64	7.11 ± 1.56	4.01 - 10.05	7.51 ± 1.66	4.01 - 12.64
L4	7.19 ± 1.86	4.69 - 12.56	5.78 ± 1.44	3.21 - 10.33	6.45 ± 1.79	3.21 - 12.56
L5	8.30 ± 2.55	5.23 - 13.58	6.10 ± 1.72	3.23 - 11.41	7.15 ± 2.41	3.23 - 13.58
L6	8.28 ± 2.55	4.74 - 15.59	6.08 ± 1.64	3.68 - 10.93	7.13 ± 2.38	3.68 - 15.59
L7	6.72 ± 1.58	4.43 - 11.08	5.30 ± 1.29	2.66 - 9.57	5.98 ± 1.59	2.66 - 11.08
L8	7.80 ± 2.40	4.39 - 13.40	5.53 ± 1.72	2.25 - 10.34	6.61 ± 2.35	2.25 - 13.40
L9	7.37 ± 2.07	4.26 - 11.97	5.49 ± 1.57	2.30 - 11.05	6.39 ± 2.04	2.30 - 11.97
R1	6.01 ± 1.83	0.84 - 9.65	5.42 ± 1.44	2.83 - 8.86	5.70 ± 1.65	0.84 - 9.65
R2	8.15 ± 2.11	4.53 - 13.25	6.73 ± 1.76	3.72 - 9.83	7.41 ± 2.05	3.72 - 13.25
R3	7.73 ± 1.93	4.42 - 13.76	6.75 ± 1.29	3.86 - 8.99	7.22 ± 1.69	3.86 - 13.76
R4	7.04 ± 1.71	4.27 - 10.93	6.02 ± 1.56	3.86 - 10.08	6.51 ± 1.70	3.86 - 10.93
R5	7.88 ± 2.39	4.52 - 12.92	6.28 ± 1.67	3.05 - 9.89	7.04 ± 2.18	3.05 - 12.92
R6	7.82 ± 2.44	4.23 - 15.42	6.17 ± 1.43	3.50 - 9.94	6.96 ± 2.13	3.50 - 15.42
R7	6.95 ± 1.51	4.82 - 10.40	5.52 ± 1.35	3.37 - 9.66	6.20 ± 1.59	3.37 - 10.40
R8	7.33 ± 2.27	4.17 - 13.38	5.65 ± 1.50	2.89 - 10.08	6.45 ± 2.08	2.89 - 13.38
R9	7.03 ± 1.87	4.20 - 11.67	5.74 ± 1.39	2.98 - 10.14	6.36 ± 1.75	2.98 - 11.67

The mean thickest part in the both groups was L3 (mean thickness 7.51 ± 1.66 mm).

The difference between the left and right calvarial thickness in the female and male groups was shown in table 5.

The mean difference of the parietal bone between the female and male groups was statistically significant at almost points (p-value < 0.05), except at point 1 that the mean difference was not statistically significant *(p-value > 0.05).*

The correlation between age and calvarial thickness was shown in table 6.

There was no statistically correlated between age and thickness when compared in the female group nor the male group, even in the both groups *(p-value > 0.05).*

The calvarial thickness measured by micrometer and three-dimensional CT scan :

The descriptive statistics for difference in two methods was shown in table 7.

The mean thickness measured by micrometer at point 5 (n = 130) was measured as 7.13 ± 2.28 mm

Table 5 The difference of calvarial thickness measured by micrometer in female and male

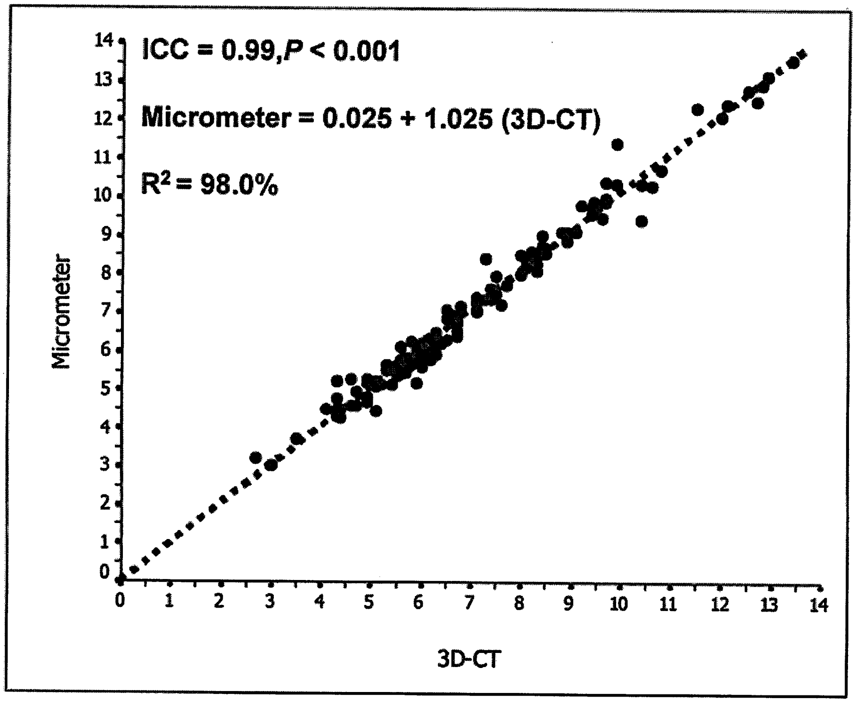
	Mean ± SD (mm)		Mean difference (mm)	95% CI of difference	*p-value*
	Female (n = 31)	Male (n = 34)			
L1	6.33 ± 2.06	5.45 ± 1.45	0.87	0.01, 1.75	*p = 0.06*
L2	8.40 ± 2.20	6.48 ± 1.77	1.92	0.94, 2.91	*p < 0.01*
L3	7.94 ± 1.67	7.11 ± 1.56	0.83	0.03, 1.63	*p = 0.04*
L4	7.19 ± 1.86	5.78 ± 1.44	1.41	0.58, 2.23	*p < 0.01*
L5	8.30 ± 2.55	6.10 ± 1.72	2.20	1.13, 3.57	*p < 0.01*
L6	8.28 ± 2.55	6.08 ± 1.64	2.21	1.13, 3.26	*p < 0.01*
L7	6.72 ± 1.58	5.30 ± 1.29	1.41	0.70, 2.13	*p < 0.01*
L8	7.80 ± 2.40	5.53 ± 1.72	2.27	1.24, 3.29	*p < 0.01*
L9	7.37 ± 2.07	5.49 ± 1.57	1.89	0.98, 2.79	*p < 0.01*
R1	6.01 ± 1.83	5.42 ± 1.44	0.59	0.22, 1.40	*p = 0.15*
R2	8.15 ± 2.11	6.73 ± 1.76	1.42	0.49, 2.38	*p < 0.01*
R3	7.73 ± 1.93	6.75 ± 1.29	0.98	0.18, 1.79	*p = 0.02*
R4	7.04 ± 1.71	6.02 ± 1.56	1.02	0.21, 1.83	*p = 0.01*
R5	7.88 ± 2.39	6.28 ± 1.67	1.60	0.56, 2.63	*p < 0.01*
R6	7.82 ± 2.44	6.17 ± 1.43	1.65	0.64, 2.66	*p < 0.01*
R7	6.95 ± 1.51	5.52 ± 1.35	1.43	0.72, 2.14	*p < 0.01*
R8	7.33 ± 2.27	5.65 ± 1.50	1.68	0.71, 2.65	*p < 0.01*
R9	7.03 ± 1.87	5.74 ± 1.39	1.30	0.48, 2.11	*p < 0.01*

Table 6 The correlation coeffcient (r) between age and calvarial thickness divided by gender and not divided by gender

	Female (n = 31)		Male (n = 34)		Total (n = 65)	
	r (age & thickness)	*p-value*	r (age & thickness)	*p*-value	r (age & thickness)	*p-value*
L1	-0.04	0.84	-0.21	0.24	-0.10	0.41
L2	0.11	0.55	-0.01	0.98	0.05	0.69
L3	-0.06	0.73	-0.03	0.88	-0.05	0.71
L4	-0.09	0.64	0.04	0.80	-0.03	0.81
L5	0.02	0.91	0.06	0.74	0.03	0.82
L6	-0.04	0.84	0.01	0.98	-0.02	0.86
L7	-0.14	0.45	0.23	0.18	0.02	0.86
L8	-0.10	0.58	0.14	0.44	-0.01	0.97
L9	0.07	0.72	0.17	0.35	0.09	0.46
R1	-0.06	0.73	-0.11	0.52	-0.09	0.50
R2	0.11	0.55	0.03	0.85	0.07	0.59
R3	-0.21	0.27	0.04	0.81	-0.10	0.42
R4	-0.01	0.95	0.03	0.89	< 0.01	0.98
R5	-0.01	0.95	0.06	0.75	0.01	0.92
R6	-0.16	0.38	-0.04	0.81	-0.11	0.39
R7	-0.01	0.94	0.20	0.26	0.07	0.56
R8	-0.04	0.84	0.01	0.97	-0.02	0.87
R9	-0.03	0.88	-0.03	0.89	-0.03	0.83

Table 7 The calvarial thickness measured by micrometer vs 3D-CT at point 5 (L5 & R5)

	Mean ± SD micrometer (mm)	Mean ± SD 3D–CT (mm)	Mean difference (mm)	95% CI of difference	*P*-value
L5 (n=65)	7.22 ± 2.38 (3.23 - 13.58)	7.03 ± 2.33 (2.70 - 13.40)	0.19	0.10,0.28	<0.01
R5 (n=65)	7.04 ± 2.18 (3.05 - 12.92)	6.97 ± 2.12 (3.00 - 12.80)	0.07	0.01,0.14	0.031
L5 & R5 (n=130)	7.13 ± 2.28 (3.05 - 13.58)	7.00 ± 2.22 (2.70 - 13.40)	0.13	0.08,0.19	<0.01



R^2 = Coefficient of determination, ICC = Intraclass correlation coefficient

Fig. 3 The relationship between micrometer and 3D-CT

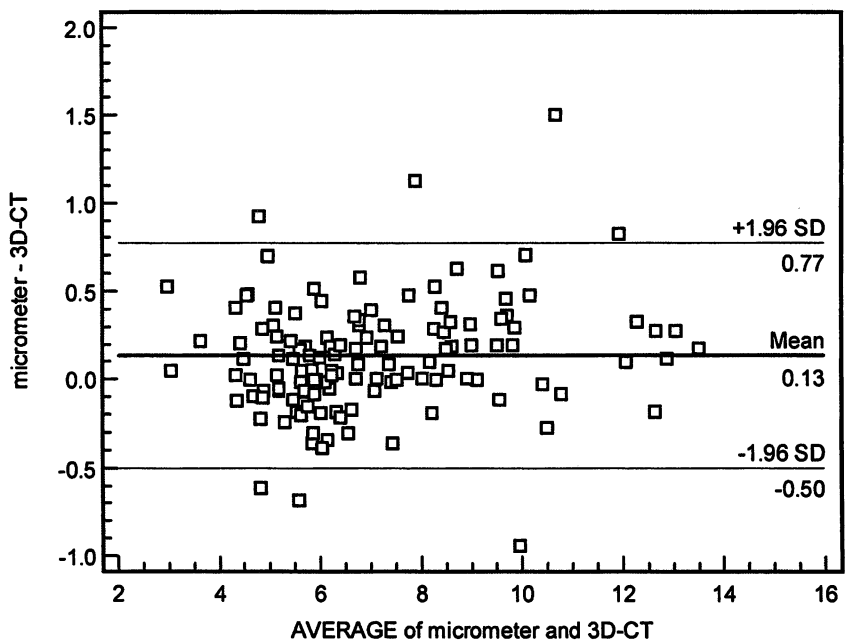


Fig. 4 The difference between two methods (micrometer - 3D-CT) were plotted against the average of the two measurements

with the micrometer and as 7.00 ± 2.22 mm with 3D-CT. The mean difference was 0.13 mm that statistically significant *(p-value < 0.01)* but the upper limit of 95% confidence interval of all difference was only 0.28 mm that not clinically significant.

The relationship between the calvarial thickness that measured by micrometer and threedimensional CT scan was shown in fig. 3.

The intraclass correlation coefficient (ICC) supported an extremely strong agreement between the two measurement modalities (ICC = 0.98, *p-value < 0.001*).

The relationship between the two measurement modalities could plotted as the graph in fig. 3 and had the equation of relationship as micrometer = 0.025 + 1.025 (3D-CT), when the coefficient of determination (R^2 = 98.0%) indicated an excellent fit.

The difference of the calvarial thickness between two methods (micrometer - 3D-CT) were plotted against the average of the two measurements in the fig. 4.

For measurements at L5 and R5 points, a 95% range of agreement was -0.50 to 0.77 (0.13 ± 2 x 0.64). One hundred and twenty-three of 130 measurements (94.62%) at L5 and R5 (micrometer - 3D-CT) were within the 95% limits of agreement. In conclusion, the agreement between the micrometer and three-dimensional CT measurements was acceptable.

Discussion

Cranial bone is used in facial aesthetic surgery. Fortunately, there have not been any intracranial complications reported during the use of cranial bone in aesthetic surgery. However, it may lead to severe intracranial complications, such as dural tears or epidural hematomas.[5] These complications may not be tolerable in aesthetic surgery, for either the patients or the surgeons. Therefore, aesthetic surgeons should do their best to minimize the risk of intracranial complications. There are few surgical anatomical studies on cranial bone thickness.[21,25] The existing studies report that the posterior parietal area is the thickest part of the cranium and it has been preferred as a bone-graft donor site. However, these anatomic observations can not be interpolated to all patients. Patients may sometimes have variations in cranial-bone thickness, such as a thin cranial bone with an absence of the diplopic space. In these cases, intracranial complications may be inevitable. Cranial donor areas have been investigated with magnetic resonance imaging during the postoperative period,[12] but preoperative evaluations have generally been neglected. Hence, the author performed a study to measure the calvarial thickness at the right and left parietal areas in Thai adult cadavers and assess its correlation to three-dimensional CT for the measurement of actual cranial thickness. The study proved that three-dimensional CT investigation of the cranial vault can be a useful method and can be carried out before bone-graft harvesting.

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