REFERENCES

[1] White T and Folkers P. Human osteology. California: Academic Press, 2000.

[2] Snell R. Clinical anatomy. Maryland: Lippincott Williams & Wilkins, 2004.

[3] Swinson B. and Adam D. Anatomy of the mandible [Online]. (n.d.). Available from: http://www.emedicine.com/ent/topic9.html [2005, June 30]

[4] Weatermark A., Bystedt H. and Konow L. Inferior alveolar nerve after mandibular osteotomies. British Journal of oral and maxillofacial surgery 1998; 36: 425-428.

[5] Qudah M. and Bataineh A. A retrospective study of selected oral and maxillofacial fractures in a group of Jordanian children. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002 Jun; 94: 310-314.

[6] Moore K. and Dalley A. Clinically oriented anatomy. Maryland: Lippincott Williams & Wilkins. 2006.

[7] Iida S., Kogo M., Sugiura T., Mima T. and Matsuya T. Retrospective analysis of 1502 patients with facial fractures. International oral and maxillofacial surgery 2001 May; 30: 286-290.

[8] Bataineh AB. Etiology and incidence of maxillofacial fractures in the north of Jordan. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998 Jan; 86: 31-35.

[9] Van As AB., Van Loghem AJ., Biermans BF., Douglas TS., Wieselthaler N. and Naidoo S. Causes and distribution of facial fractures in a group of South African children and the value of computed tomography in their assessment. International oral and maxillofacial surgery 2006 Sep; 35: 903-906.

[10] Maladiere E., Bado F., Meninguad J., Guilbert F. and Bertrand C. Aetiology and incidence of facial fractures sustained during sports: a prospective study of 140 patients. International oral and maxillofacial surgery 2001 Feb; 30 : 291-295.

[11] Brasileiro BF. And Passeri LA. Epidemiological analysis of maxillofacial fractures in Brazil: A 5-year prospective study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006 Jul; 102: 28-34.

[12] Hayward J., Richardson ER. and Malhotra SK. The mandibular foramen: Its anteroposterior position. Oral Surg 1977 Dec; 44: 837-843.

[13] Boonruangsri P., Uttaravichien A. and Namking M. The position of the mandibular foramen in the adult mandibles of Northeastern Thai. Srinagarind Hosp Med J 1991; 6(3): 147-154.

[14] Dover WR. The Mandibular block injection, why it sometime fails. Oral Health 1971; 6: 12-14.

[15] Moiseiwitsch RD. Position of the mental foramen in a North American, white population. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998 Nov; 85: 457-460.

[16] Boonpiruk N. Location of mandibular foramen in Thai people. J Dent Ass Thai 1975 Jul-Aug; 25(4): 173-177.

[17] Nichoson ML. A study of the position of the mandibular foramen in the adult human mandible. The anatomy racord 1985 Oct; 212: 110-112.

[18] Hwang TJ., Hsu SC., Huang OF. And Guo MK. Age changes in location of Mandibular foramen. Zhonghua Ya Yi Xue Hui ZaZhi 1990 Sep; 9(3): 98-103.

[19] Fontoura RA., Vasconcellos HA. And Siqueira AE. Morphologic basis for the Intraoral vertical ramus Osteotomy: anatomic and radiographic localization of the mandibular foramen. J Oral Maxillofac Surg 2002; 60: 660-665.

[20] Oquz O. and Bozkir MG. Evaluation of location of mandibular and mental foramina in dry, young, adult human male, dentulous mandible. West Indian Med J 2002 Mar; 51(1): 14-16.

[21] Huang J. Study on the location of mandibular foramen and the measurement of sigmoid notch and ramus. Shanghai Kou Qiang Yi Xue 2003 Aug; 12:284-287.

[22] Narayana K. and Prashanthi N. Incidence of large accessory mandibular foramen in human mandibles. Eur J Anat 2003 Nov; 7(3): 139-141.

[23] Kilarkaje N., Nayak SR., Narayan P. and Prabhu LV. The location of the mandibular foramen maintains absolute bilateral symmetry in mandibles of different age-groups. Hong Kong Dental Journal 2005 Jun; 2: 35-37.

[24] Captier G., Lethuilier J., Oussaid M., Canovas F. and Bonnel F. Neural symmetry and functional asymmetry of the mandible. Surg Radiol Anat 2006 Mar; 28: 379-386.

[25] Wang TM., Shih C., Liu JC. And Kuo KJ. A clinical and anatomical study of the location of the mental foramen in adult Chinese mandibles. Acta Anat 1986; 126(1): 29-33.

[26] Sawyer DR., Kiely ML. and Marsha AP. The frequency of accessory mental foramina in four ethnic groups. Archives of oral biology 1998 Dac; 43: 417-420.

[27] Cutright B., Quillopa N. and Schubert W. An anthropometric analysis of the key foramina for maxillofacial surgery. J Oral Maxillofac Surg 2003; 61: 354-357.

[28] Agthong S., Huanmanop T. and Chentanez V. Anatomical variations of the supraorbital, Infraorbital, and mental foramina related to gender and side. J Oral Maxillofac Surg 2005; 63: 800-804.

[29] Mbajiorgu FE., Zivanovic S., Asala SA. and Mawera G. A pilot of the mandibular angle in black Zimbabweans. Cent Afr J Med 1996 Oct; 42(10): 185-287.

[30] Ceylan G., Yanikoglu N., Yilmaz AB. And Ceylan Y. Changes in the mandibular angle in the dentulous and edentulous ststes. The journal of prosthetic dentistry 1998; 80: 680-684.

[31] Eisenburger M., Haubitz B. Wolter S. and Tschernitschek H. The human mandibular intercondylar angle measured by computed tomography. Archives of oral biology 1999 May; 44: 947-951.

[32] John DS., Mulliken JB., Kaban LB. and Padwa BL. Anthropometric analysis of mandibular asymmetry in infants with deformational posterior plagiocephaly. J Oral Maxillofac Surg 2002; 60: 873-877.

[33] Mbajiorgu EF. and EKanem AU. The mandibular angles of dry humans from north eastern arid zone of Nigeria. Cent Afr J Med 2002Jan-Feb; 48(1-2): 9-13.

[34] Xie QF. and Ainamo A. Correlation of gonial angle size with cortical thickness, height of the mandibular residual body, and duration of edentulism. J Prosthet Dent 2004; 91: 477-482.

[35] Merrot O., Vacher C., Merrot S., Godlewski., Frigard B. and Goudot P. Changes in the edentate mandible in the elderly. Surg Radiol Anat 2005; 27: 265-270.

[36] Lazic B., Tepavcevic B., Keros J., Komar D., stanicic T. and Azinovic Z. Intercondylar distances of the human temporomandibular joints. Coll Antropol 2006 Mar; 30(1): 37-41.

[37] Puisoru M., Forna N., Fatu AM., Fatu R. and Fatu C. Analysis of mandibular variability in humans of different geographic areas. Ann Anat 2006: 1-8.

[38] Ogura M., Al-kalaly A., Sakashita R. and Miyawaki S. Relationship between anteroposterior cranial vault deformation and mandible morphology in a pre-Columbian population. Am J Orthod Dentofacial Orthop 2006; 130: 535-539.

[39] Kemkes-Grottenthaler A., Lobig F. and Atock F. Mandibular ramus flexure and gonial eversion as morphologic indicators of sex. HOMO 2002; 53(2): 97-111.

[40] Loth SR. and Henneberg M. Mandibular ramus flexure: a new morphologic indicator of sexual dimorphism in the human skeleton. Am J Phys Anthrop 1996; 99: 473-485.

[41] Loth SR. and Henneberg M. Gonial eversion: facial architecture, not sex. HOMO 2000; 51: 81-89.

[42] Balci Y., Yavuz MF. and Cagdir S. Predictive accuracy of sexing the mandible by ramus flexure. HOMO-Journal of Comparative 2005 July; 55: 229-237.

[43] Ihunwo AO. And Phukubye P. The frequency and anatomical features of torus mandibularis in a Black South African population. Journal of Comparative human biology 2006 Mar ; 57: 253-262.

[44] Meyer C., Kahn JL. Photoelastic analysis of bone deformation in the region of the mandibular condyle during mastication. Journal of Cranio-Maxillofacial Surgery 2002; 30: 160-169.

[45] Gray H. and Jacob J. Anatomy of the human body [Online]. (n.d.). Available from: http://www.bartleby.com/107/44.html [2006, January 29]

[46] Guo HK., Kim HJ. and Liu MC. Structure of the human mandible [Online]. (n.d.). Available from: http//iris3.med.tufts.edu/dentgross/labguide/Mandible.html [2005, December 15]

[47] Adou A. Orthodontic surgery of the mandible [Online]. (n.d.). Available from: http//herkules.oulu.fi/isbn9514267508/html/c237.html [2005, November 14]

[48] Kapnidou JE. Sagittal splitting of the mandible [Online]. (n.d.). Available from: http//www.bergenora/surgerg.com/proc-orthognathiv.htm [2005, December 3]

APPENDICES

APPENDIX A

1. A general knowledge of the mandible

The mandible, the largest and strongest bone of the face, serves for the reception of the lower teeth. It consists of a curved, horizontal portion, the body, and two perpendicular portions, the rami, which unite with the ends of the body nearly at right angles.

The Body is curved somewhat like a horseshoe and has two surfaces and two borders. The external surface is marked in the median line by a faint ridge, indicating the symphysis or line of junction of the two pieces of which the bone is composed at an early period of life. This ridge divides below and encloses a triangular eminence, the mental protuberance, the base of which is depressed in the center but raised on either side to form the mental tubercle. On either side of the symphysis, just below the incisor teeth, is a depression, the incisive fossa, which gives origin to the mentalis and a small portion of the orbicularis oris. Below the second premolar tooth, on either side, midway between the upper and lower borders of the body, is the mental foramen, for the passage of the mental vessels and nerve. Running backward and upward from each mental tubercle is a faint ridge, the oblique line, which is continuous with the anterior border of the ramus; it affords attachment to the quadratus labii inferioris and triangularis; the platysma is attached below it. (Figure 8.)

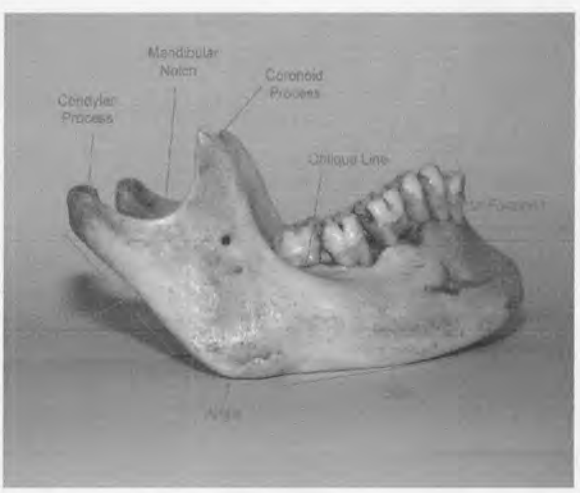

Figure 9. Outer surface of the mandible [46]

The internal surface is concave from side to side. Near the lower part of the symphysis is a pair of laterally placed spines, termed the mental spines, which give origin to the Genioglossi. Immediately below these is a second pair of spines, or more frequently a median ridge or impression, for the origin of the geniohyoidei. In some cases the mental spines are fused to form a single eminence, in others they are absent and their position is indicated merely by an irregularity of the surface. Above the mental spines a median foramen and furrow are sometimes seen; they mark the line of union of the halves of the bone. Below the mental spines, on either side of the middle line, is an oval depression for the attachment of the anterior belly of the digastricus. Extending upward and backward on either side from the lower part of the symphysis is the mylohyoid line, which gives origin to the mylohyoideus; the posterior part of this line, near the alveolar margin, gives attachment to a small part of the constrictor pharyngis superior, and to the pterygomandibular raphé. Above the anterior part of this line is a smooth triangular area against which the sublingual gland rests, and below the hinder part, an oval fossa for the submaxillary gland. (Figure 9.)

Figure 10. Inner surface of the mandible [46]

The superior or alveolar border, wider behind than in front, is hollowed into cavities, for the reception of the teeth; these cavities are sixteen in number, and vary in depth and size according to the teeth which they contain. To the outer lip of the superior border, on either side, the buccinator is attached as far forward as the first molar tooth. The inferior border is rounded, longer than the superior, and thicker in front than behind; at the point where it joins the lower border of the ramus a shallow groove; for the external maxillary artery, may be present.

The ramus is quadrilateral in shape, and has two surfaces, four borders, and two processes. The lateral surface is flat and marked by oblique ridges at its lower part; it gives attachment throughout nearly the whole of its extent to the masseter. The medial surface presents about its center the oblique mandibular foramen, for the entrance of the inferior alveolar vessels and nerve. The margin of this opening is irregular; it presents in front a prominent ridge, surmounted by a sharp spine, the lingula mandibulae, which gives attachment to the sphenomandibular ligament; at its lower and back part is a notch from which the mylohyoid groove runs obliquely downward and forward, and lodges the mylohyoid vessels and nerve. Behind this groove is a rough surface, for the insertion of the pterygoideus internus.

The mandibular canal runs obliquely downward and forward in the ramus, and then horizontally forward in the body, where it is placed under the alveoli and communicates with them by small openings. On arriving at the incisor teeth, it turns back to communicate with the mental foramen, giving off two small canals which run to the cavities containing the incisor teeth. In the posterior two-thirds of the bone the canal is situated nearer the internal surface of the mandible; and in the anterior third, nearer its external surface. It contains the inferior alveolar vessels and nerve, from which branches are distributed to the teeth. The lower border of the ramus is thick, straight, and continuous with the inferior border of the body of the bone. At its junction with the posterior border is the angle of the mandible, which may be either inverted or everted and is marked by rough, oblique ridges on each side, for the attachment of the masseter laterally, and the pterygoideus internus medially; the stylomandibular ligament is attached to the angle between these muscles. The anterior border is thin above, thicker below, and continuous with the oblique line. The posterior border is thick, smooth, rounded, and covered by the parotid gland. The upper border is thin, and is surmounted by two processes, the coronoid in front and the condyloid behind, separated by a deep concavity, the mandibular notch.

The coronoid process is a thin, triangular eminence, which is flattened from side to side and varies in shape and size. Its anterior border is convex and is continuous below with the anterior border of the ramus; its posterior border is concave and forms the anterior boundary of the mandibular notch. Its lateral surface is smooth, and affords insertion to the temporalis and masseter. Its medial surface gives insertion to the temporalis, and presents a ridge which begins near the apex of the process and runs downward and forward to the inner side of the last molar tooth.

Between this ridge and the anterior border is a grooved triangular area, the upper part of which gives attachment to the temporalis, the lower part to some fibers of the buccinator.

The condyloid process is thicker than the coronoid, and consists of two portions: the condyle, and the constricted portion which supports it, the neck. The condyle presents an articular surface for articulation with the articular disk of the temporomandibular joint; it is convex from before backward and from side to side, and extends farther on the posterior than on the anterior surface. Its long axis is directed medialward and slightly backward, and if prolonged to the middle line will meet that of the opposite condyle near the anterior margin of the foramen magnum. At the lateral extremity of the condyle is a small tubercle for the attachment of the temporomandibular ligament. The neck is flattened from before backward, and strengthened by ridges which descend from the forepart and sides of the condyle. Its posterior surface is convex; its anterior presents a depression for the attachment of the pterygoideus externus. The mandibular notch, separating the two processes, is a deep semilunar depression, and is crossed by the masseteric vessels and nerve [45].

2. **Orthognathic surgery of the mandible**

Orthognathic surgery refers to surgical procedures designed to correct jaw deformities. Orthognathic procedures are divided into three categories: maxillary surgery, mandibular surgery, and bimaxillary procedures. Indications for orthognathic surgery include impaired mastication, temporomandibular pain and dysfunction, sleep apnea and susceptibility to caries and periodontal disease.

1. Sagittal splitting of the mandible; the incision is made inside the mouth in the posterolateral region of the mandible at the anterior border of the ascending ramus. After the bone has been fully exposed and the inferior alveolar nerve appears on the inner surface of the ascending ramus with its accompanying vessels, which should be preserved particularly, the ascending ramus of the mandible is divided longitudinally over the angle of the mandible as far as the region of the most posterior molar teeth. Because of this longitudinal splitting of the bone, carried out using fine cutters and chisels, the tooth-bearing part of the mandible can be moved forward or backward, and there is always an adequate bone attachment surface for subsequent secure screw fixation of the mandible.

After the mandible has been split longitudinally (sagittal splitting of the mandible) on both sides, the tooth-bearing part of the mandible can be moved forward or backward depending on the malposition of the mandible and can be placed in the new position through the plastic splint made in the course of the model operation (see above) and fixed by means of wire loops to the orthodontic wire arches. While securing the position of the head of the mandible (see above), the bone is joined with 3 titanium screws on either side. After screw placement, the wire loops on the teeth are removed again and the wounds in the mouth in the region of the angle of the mandible are closed bilaterally with silk sutures. These sutures are removed after about 10 days. (Figure 10.)

Figure 11. Sagittal splitting of the mandible

2. Genioplasty; In the course of the osteotomy operations decribed above, it can happen that the chin can appear too flat or too prominent depending on the degree and direction of bone displacement. A slice of the mandible in the region of the chin can be divided through access through the mandibular sulcus and moved forward or backward according to the preplanning on the patient and according to analysis of the lateral X-ray view. The displaced slice of chin bone is secured to the mandible after about 10 days. Genioplasty can also be performed if necessary without the ja with plates and screws. The mucosa is closed with silk sutures which are removed w osteotomy operations described above if an aesthetic improvement in the external appearance can be expected as a result. Your oromaxillofacial surgeon will give you precise information about the nature and scope of the operations. (Figure 11.)

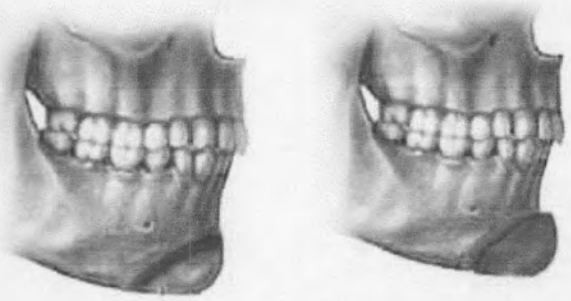

Figure 12. Genioplasty

3. Vertical ramus osteotomy; The vertical ramus osteotomy divides the mandibular ramus from the sigmoid notch down to the angular region. The bony cut is made posterior to the point where the mandibular nerve enters the bone. The vertical body osteotomy involves the removal of a piece of the mandibular body usually through combined extraoral and intraoral approaches Indications for this procedure are mandibular prognathism where the body is long in relation to the ramus or when it is useful to utilize space from planned extractions sites or already missing teeth [47, 48] (Figure 12.)

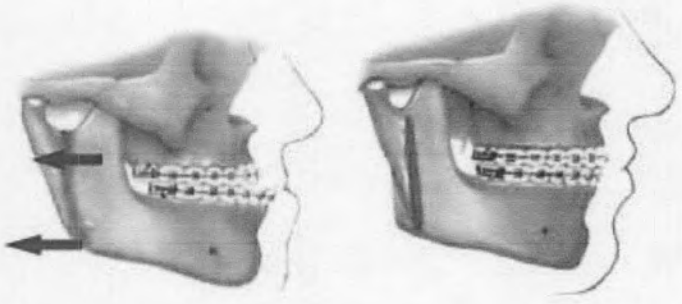

Figure 13. Vertical ramus osteotomy

APPENDIX B

Paired student's t test for side difference (SPSS Version 14)

Right – Left	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1. MDF – Condyloid process	-.58056	2.11573	.15770	-.89174	-.26937	-3.681	179	.000
2. MDF – Mandibular notch	.23692	1.74132	.12979	-.01920	.49303	1.825	179	.070
3. MDF – Coronoid process	-.57094	2.15252	.16044	-.88754	-.25435	-3.559	179	.000
4. MDF – Internal oblique ridge	-.89497	1.59149	.11862	-1.12905	-.66089	-7.545	179	.000
5. MDF – Third molar	.21942	1.83637	.13687	-.05068	.48951	1.603	179	.111
6. MDF – Symphysis menti	.22906	1.93678	.14436	-.05581	.51392	1.587	179	.114
7. MDF – Pre angular notch	-.45369	2.06354	.15381	-.75720	-.15019	-2.950	179	.004
8. MDF – Inferior border of the ramus	-.06206	1.81848	.13554	-.32952	.20541	-.458	179	.648
9. MDF – Angle of the mandible	.02475	2.03483	.15167	-.27454	.32404	.163	179	.871
10. MDF – Anterior border of the ramus	-.16311	1.53568	.11446	-.38898	.06276	-1.425	179	.156
11. MDF – Posterior border of the ramus	.46072	1.32829	.09901	.26535	.65609	4.654	179	.000
12. Mandibular foramen width	.31417	2.85274	.21263	-.10542	.73375	1.478	179	.141
13. MTF – Inferior rim of the mandible	.22050	1.06707	.07953	.06355	.37745	2.772	179	.006

Right – Left	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
14. MTF – Mandible symphysis	-.33897	1.44404	.10763	-.55136	-.12658	-3.149	179	.002
15. MTF – Posterior border of the ramus	.47706	2.04294	.15227	.17658	.77753	3.133	179	.002
16. MTF – Condyloid process	.70597	2.53528	.18897	.33308	1.07887	3.736	179	.000
17. Alveolar crest – Inferior rim of mandible	-.66656	8.68898	.64764	-1.94454	.61143	-1.029	179	.305
18. MTF width (Horizontol dimensions)	-.12786	1.06013	.07902	-.28379	.02806	-1.618	179	.107
19. MTF width (Vertical dimensions)	-.03653	.52880	.03941	-.11430	.04125	-.927	179	.355
20. The total length of the mandible	-.03292	2.08426	.15535	-.33947	.27364	-.212	179	.832
21. The total length of the ramus	.40664	2.55044	.19010	.03152	.78176	2.139	179	.034
22. The height of the ramus	-.11886	2.16609	.16145	-.43745	.19973	-.736	179	.463
23.Menton – Gonian distance	-.16172	2.32420	.17324	-.50357	.18012	-.934	179	.352
24. Width of the mandibular notch	.51306	1.80990	.13490	.24685	.77926	3.803	179	.000
25. Depth of mandibular notch	.27844	1.25404	.09347	.09400	.46289	2.979	179	.003
26. Minimal width of mandibular ramus	-.11722	2.21136	.16483	-.44247	.20803	-.711	179	.478
27. Mandibular angle	-.18611	1.48365	.11058	-.40433	.03211	-1.683	179	.094
28. Height of the mandibular body	-.10000	1.58829	.11838	-.33361	.13361	-.845	179	.399

APPENDIX C

Comparison of distances from the mandibular foramen and the mental foramen to surrounding bony landmarks on the mandible and mandibular dimensions, in the previous study

1. MDF – Condyloid process

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Kilarkaje et al.	2005	93	Hong Kong	41.10 ± 3.90	41.10 ± 3.80		/	
Captier et al.	2006	60	France	44.84 ± 4.04	44.60 ± 3.06		/	
Our study	2007	180	Thai	41.08 ± 3.89	41.66 ± 3.75	41.37 ± 3.82	/	

2. MDF – Mandibular notch

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Nicholson et al.	1985	80	East Indian	23.60 ± 3.50	23.30 ± 3.50		/	
Oquz et al.	2002	34	Turkish	22.37	22.17			
Huang et al.	2003	74 79	Shanghai-M Shanghai-FM			24.50 23.13		
Kilarkaje et al.	2005	132	Kuwait	21.60 ± 0.31	21.60 ± 0.34		/	
Captier et al.	2006	60	France	24.88 ± 3.17	24.13 ± 3.08			< 0.01
Our study	2007	180	Thai	22.84 ± 3.22	22.60 ±3.29	22.72 ± 3.25	/	

3. MDF – Coronoid process

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Nicholson et al.	1985	80	East Indian	38.80 ± 3.80	38.60 ± 4.40		/	
Our study	2007	180	Thai	38.49 ± 4.18	39.06 ± 3.99	38.78 ± 4.09		0.00

4. MDF – Internal oblique ridge

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Boonpiruk et al.	1975	290	Thai			14.3 ± 0.17	/	
Nicholson et al.	1985	80	East Indian	12.40 ± 2.00	12.30 ± 1.80		/	
Boonrungsri et al.	1990	49	Thai	13.15 ± 1.87	13.00 ± 1.82		/	
Our study	2007	180	Thai	12.27 ± 1.88	13.16 ± 2.21	12.71 ± 2.10		0.00

5. MDF – Third molar

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Nicholson et al.	1985	80	East Indian	19.6 ± 3.80	19.30 ± 3.60		/	
Kilarkaje et al.	2005	132	Kuwait	20.60 ± 4.1	20.7 ± 3.00		/	
Our study	2007	180	Thai	18.76 ± 3.43	18.54 ± 3.54	18.65 ± 3.49	/	

6. MDF – Symphysis menti

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Kilarkaje et al.	2005	132	Kuwait	69.80 ± 4.60	6.89 ± 7.60		/	
Captier et al.	2006	60	France	71.95 ± 3.59	71.93 ± 3.84		/	
Our study	2007	180	Thai	69.73 ± 3.84	69.50 ± 3.85	69.62 ± 3.84	/	

7. MDF – Pre angular notch

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Captier et al.	2006	60	France	29.57 ± 4.25	29.40 ± 3.99		/	
Our study	2007	180	Thai	27.53 ± 3.86	27.98 ± 3.87	27.75 ± 3.87		0.004

8. MDF – Inferior border of the ramus

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Oquz et al.	2002	34	Turkish	30.97	29.75			
Our study	2007	180	Thai	26.08 ± 3.84	26.15 ± 3.95	26.12 ± 3.89	/	

9. MDF – Angle of the mandible

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Nicholson et al.	1985	80	East Indian	22.70 ± 3.80	22.60 ± 3.50		/	
Kilarkaje et al.	2005	132	Kuwait	25.10 ± 4.20	24.70 ± 4.40		/	
Our study	2007	180	Thai	24.68 ± 4.18	24.65 ± 4.36	24.66 ± 4.27	/	

10. MDF – Anterior border of the mandibular ramus

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Hayward et al.	1977	45 62	1.Asiatic 2. black and white Americans	15.67 15.21	15.73 15.13		/ /	
Nicholson et al.	1985	80	East Indian	16.00 ± 2.10	16.80 ± 2.20		/	
Boonruangsri	1990	49	Thai	20.09 ± 1.77	20.17 ± 1.86		/	
Huang et al.	2003	74 79	Shanghai-M Shanghai-FM			16.75 16.08		
Kilarkaje et al.	2005	132	Kuwait	18.50 ± 1.90	1.850 ± 2.00		/	
Our study	2007	180	Thai	19.67 ± 2.71	19.84 ± 2.55	19.75 ± 2.63	/	

11. MDF – Posterior border of the mandibular ramus

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Nicholson et al.	1985	80	East Indian	14.90 ± 2.10	14.60 ± 1.90		/	
Boonruangsri et al	1990	49	Thai	20.74 ± 1.79	20.46 ± 2.05		/	
Oquz et al.	2002	34	Turkish	14.09	14.37			
Our study	2007	180	Thai	14.72 ± 2.00	14.26 ± 1.94	14.49 ± 1.99		0.00

12. MDF width

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Hayward et al.	1977	45 62	1.Asiatic 2. black/white Americans	8.10 8.60	8.52 8.90			
Our study	2007	180	Thai	7.75 ± 2.97	7.44 ± 1.16	7.59 ± 2.25	/	

13. MTF – Inferior rim of the mandible

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Oquz et al.	2002	34	Turkish	14.61	14.29			
Agthong et al.	2005	110	Thai	14.50 ± 0.02	14.44 ± 0.01			
Captier et al.	2006	60	France	13.45 ± 1.52	13.64 ± 1.76		/	
Our study	2007	180	Thai	13.64 ± 1.59	13.42 ± 1.53	13.53 ± 1.53		0.006

14. MTF – Mandible symphysis in the midline

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Wang et al.	1986	100	Chinese			28.06		
Cutright et al.	2003 (Spain)	20	White-M			22.50 ± 0.40	/	
		20	Black-M			22.90 ± 0.60	/	
		20	White-FM			20.50 ± 0.40	/	
		20	Black-FM			21.90 ± 0.40	/	
Captier et al.	2006	60	France	26.05 ± 1.95	26.10 ± 2.02		/	
Agthong et al.	2005	110	Thai	28.00 ± 0.02	27.80 ± 0.02		/	
Our study	2007	180	Thai	27.26 ± 2.03	27.60 ± 2.18	27.43 ± 2.11		0.002

15. MTF – Posterior border of the ramus

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Captier et al.	2006	60	France	73.84 ± 4.62	74.16 ± 4.61		/	
Wang et al.	1986	100	Chinese			74.14		
Our study	2007	180	Thai	71.35 ± 4.26	70.87 ± 3.97	71.11 ± 4.12		0.002

16. MTF – Condyloid process

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Captier et al.	2006	60	France	98.09 ± 4.25	98.16 ± 4.18		/	
Our study	2007	180	Thai	95.43 ± 4.82	94.72 ± 4.88	95.08 ± 4.86		0.000

17. Alveolar crest – Inferior rim of the mandible

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Wang et al.	1986	100	Chinese			30.29		
Merrot et al.	2005	41	France			27.22 ± 3.10		
Our study	2007	180	Thai	28.98 ± 2.75	29.65 ± 8.92	29.31 ± 6.60	/	

18. MTF width (Horizontal dimensions)

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Oquz et al.	2002	34	Turkish	2.93	3.14			
Our study	2007	180	Thai	3.64 ± 1.08	3.77 ± 0.68	3.70 ± 0.91	/	

19. MTF width (Vertical dimensions)

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Oquz et al.	2002	34	Turkish	2.38	2.64			
Our study	2007	180	Thai	2.94 ± 0.57	2.98 ± 0.58	2.96 ± 0.57	/	

20. The total length of the mandible (Gnathion – Condyloid process)

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Captier et al.	2006	60	France	126.42 ± 4.93	126.81 ± 4.99		/	
Our study	2007	180	Thai	122.61 ± 6.28	122.65 ± 6.31	122.63 ± 6.29	/	

21. The total length of the ramus (Condyloid process – Angle of the mandible)

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Mbajiorgu et al.	1996	239	Zimbabweans			Female – 61.30 Male – 59.80		
Captier et al.	2006	60	France	65.96 ± 6.24	66.64 ± 4.99			< 0.01
Our study	2007	180	Thai	63.73 ± 5.47	63.33 ± 5.50	63.53 ± 5.48		0.034

22. The height of the ramus (Mandibular notch – Pre angular notch)

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Fontoura	2002	280	Brazil			49.40 ± 4.20	/	
Captier et al.	2006	60	France	53.76 ± 5.49	53.92 ± 5.21		/	
Our study	2007	180	Thai	50.64 ± 4.42	50.76 ± 4.29	50.70 ± 4.35	/	

23. Menton-gonian distance (Gnathion – Angle of the mandible)

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Captier et al.	2006	60	France	89.43 ± 4.85	89.28 ± 4.49		/	
Our study	2007	180	Thai	81.85 ± 6.45	82.01 ± 6.64	81.93 ± 6.53	/	

24. Width of the mandibular notch

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Huang et al.	2003	74 79	Shanghai-M Shanghai-FM			34.20 32.69		
Captier et al.	2006	60	France	28.29 ± 3.12	28.64 ± 3.36			< 0.05
Our study	2007	180	Thai	33.76 ± 3.24	33.25 ± 3.29	33.50 ± 3.27		0.000

25. Depth of the mandibular notch

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Huang et al.	2003	74 79	Shanghai-M Shanghai-FM			15.33 14.49		
Captier et al.	2006	60	France	14.57 ± 1.85	15.35 ± 2.44			< 0.05
Our study	2007	180	Thai	14.92 ± 1.98	14.64 ± 1.87	14.78 ± 1.93		0.003

26. Minimal width of mandibular ramus

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Nicholson et al.	1985	80	East Indian	29.80 ± 3.20	29.80 ± 3.0		/	
Captier et al.	2006	60	France	31.33 ± 3.43	31.23 ± 3.24		/	
Our study	2007	180	Thai	34.73 ± 3.08	34.84 ± 3.28	34.79 ± 3.18	/	

27. Mandibular angle

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (degree)	Left (degree)	Total mean (degree)	Symmetry	Asymmetry
Nicholson et al.	1985	80	East Indian	115.8 ± 11.0	116.10 ± 7.3		/	
Mbajiorgu et al.	1996	23 9	Zimbabweans			Female – 128 Male – 123.06		
Merrot et al.	2005	41	France			106.32 ± 11.54		
Our study	2007	180	Thai	119.67 ± 4.65	119.86 ± 4.64	119.76 ± 4.64	/	

28. Height of the mandibular body

Researcher	Year	No	Race	The mean distance			Paired *t* test (P valuve)	
				Right (mm)	Left (mm)	Total mean (mm)	Symmetry	Asymmetry
Puisoru et al.	1985	80	Europe, Middle Orient, Asia, Africa -Female -Male			 21.00 ± 10.35 22.00 ± 9.56		
Our study	2007	180	Thai	26.84 ± 2.24	26.94 ± 2.31	26.89 ± 2.27	/	

29. Intercondyloid distance

Researcher	Year	No	Race	Total mean (mm)
Lazic	2006	101	Zagreb	126
Our study	2007	180	Thai	100.08 ± 5.96

30. Intercoronoid distance

Researcher	Year	No	Race	Total mean (mm)
Ogura	2006	44	Japan	95.39 ± 5.60
Our study	2007	180	Thai	93.87 ± 5.69

31. Intergonial distance

Researcher	Year	No	Race	Total mean (mm)
Merrot	2005	110	France	95.41 ± 9.94
Our study	2007	180	Thai	94.00 ± 6.78

BIOGRAPHY

Mr. Supakit Pisitpaibool was born on June 30, 1982 in Udonthani, Thailand. He received his Bachelor degree of Science (Medical Science) in 2004 from the Faculty of Science, Burapha University, Chonburi, Thailand. He has enrolled in graduate program for Master degree of Medical Science at Chulalongkrorn University since 2004.