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Computed Tomography Study of the Biometric and Morphometric Characteristics of the Occipital Condyles among Malaysian Population

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ABSTRACT

Background: The occipital condyles connect the cranium to the upper cervical spine. It is an important component for the motion and stabilization of the craniocervical junction. The accessibility of the occipital condyles should be carefully determined to ensure success of cranioservical fixation techniques. It is known that the race and or the gender can affect the anatomical parameters. Aim: this research aimed to use radiographical analysis with computed tomographic (CT) scanning to determine the characteristics of the occipital condyles shape and measurements among the Malaysian population. A retrospective study was conducted in Hospital Shah Alam, Selangor, Malayasia, to include 96 occipital condyles (20 females and 28 males) adult Malaysian aged more than 20 years old. Methods: Studies were done on multidetector computed tomography (MDCT) scanner with volumeteric acquisition and multiplanar reconstruction deploying High Resolution Bone Window Alogrithm in axial, sagittal and coronal planes. Six measurements were studied; Occipital Condyle Width in axial plane, length in axial and sagittal planes, Occipital condyle height in sagittal and coronal planes and screw angle. Results: Measurements are bilaterally symmetrical and also the screw angle that is has mean measurement as 31.47±5.47 and 30.95±6.99 degree on the left and right side respectively. Generally male measurements are bigger than females. The kidney shape occipital condyles are the most common among Malaysian males and females. Conclusion: It can be concluded that the Malaysian population have generally identical measurements that can represent a tool for characterization of the Malaysian population and it is recommended to have wider and deeper studies to look for subracial variations and to compare the Malaysian with other races.

Keywords:
Malaysian, racial characterization, gender variations, occipital condyles, computed tomography

Introduction

The occipital condyles connect the cranium to the upper cervical spine. It is an important component for the motion and stabilization of the craniocervical junction (1). The stability of occipitocervical junction can be affected by pathologies as covering inflammation, injury, cancer, and deformity (2- 4) that require surgical fixation techniques with internal instrumentation (4 - 6). There are different techniques that started with simple posterior onlay bone grafts then, rigid posterior fixation systems using rods, screws, or plates (7, 8) and recently proposed techniques to use the occipital condyles as the fixation points. This has been tested in cadavers for (9) and clinical cases (10
- 13). The accessibility of the occipital condyles should be carefully determined to ensure success of such cranioservical fixation techniques. It is known that the race and or the gender can affect the anatomical parameters (14 - 17). Biometric racial variations are known to exist at different bones e.g., maxillary sinus (18), supraorbital foramen (19), and bodily measurements e.g., ear

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(20), eye (21), head (22 -23) and face (24). This study aimed to study the racial characteristics of the occipital condyles shape and measurements among the Malaysian population by radiographical analysis with computed tomographic (CT) scanning to study if there is bilateral or gender variations characterizing the occipital condyles.

METHODOLOGY

A retrospective study was conducted in Hospital Shah Alam, Selangor, Malayasia, in the period from January 2017 to November 2018 to include 60 random volumetric occipito-cervical CT scans for adult Malaysian, aged more than 20 years old.

Cases showing incomplete scans of the occipital condylar region or lesions e.g. fracture, tumor, infection, inflammatory disease, previous surgery in the occipital area, and congenital malformations were excluded from the study. Hence, 12 cases were omitted leaving 48 cases. Studies were done on multidetector computed tomography (MDCT) scanner (SOMATOM Definition AS, 64 slice, Siemens) with minmum slice thickness of 1mm volumeteric acquisition and multiplanar reconstruction deploying High Resolution Bone Window Alogrithm in axial, sagittal and coronal planes.

The images were viewed and measurements obtained on Prime Dicom Viewer Software using inbuilt Electronic Caliper. Measurements were taken by expert radiologist and repeated two times for quality assurance.

Twelve measurements were studied, six for each occipital condyle; Width in axial plane, length (anteroposterior dimension) in axial and sagittal planes, height in sagittal and coronal planes and screw angle (25). Length or anteroposterior (AP) in the axial plane was taken along the Projected Screw Trajectory which corresponds to the long axis of the condyle, placed in the center of the condyle and directed anteromedially in the longest axis to maximize the length and safety of the screw. Length was also measured as the longest axis in the AP orientation on a sagittal plane. length was measured from the outer cortex of the posterior wall to the outer cortex of the anterior wall. The transverse Width was a line perpendicular to the midpoint of the long axis on an axial plane. Height was measured in the sagittal and coronal planes perpendicularly from the hypoglossal canal to the condylar cartilage. The Screw Angle was measured in the axial plane between the midline and a line drawn through the condyle mimicking ideal screw placement corresponding to the axial length measurement described earlier (figure 1).

There is no ample literatue describing the condylar shape on CT, so determination of condylar shape in this research was referred to work done by (17) who worked on 202 dry skulls and described 8 shapes (types) for the occipital condyles. The shapes of the condyles were discribed viewing the skull from the inferior aspect which corresponds to the axial plane in CT image, so this current research used the axial images for measuring the Axial Length and Width and depicted 4 shapes of the condyles: Kidney, Oval, Bullet (triangular) and Rectangular.

All the data were keyed in Statistical Package for the Social Sciences (SPSS) and analysed to have descriptive and comparative statistics. The significance level in all tests was $p < 0.05$.

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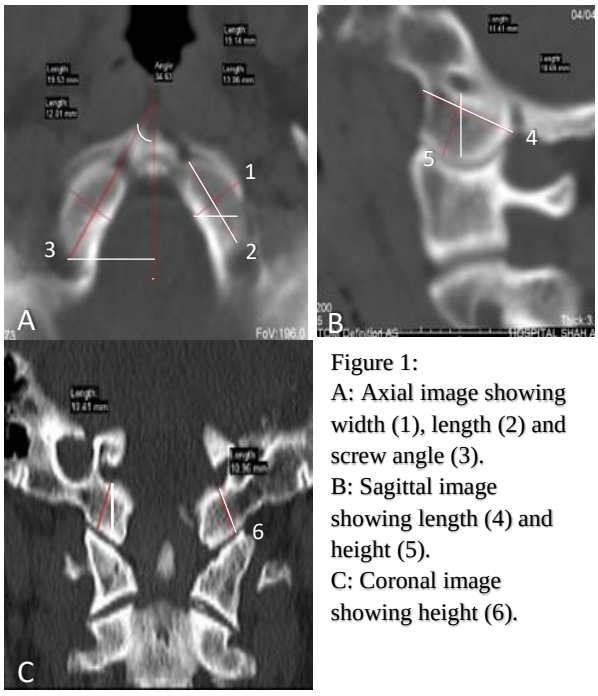

Figure 1:
A: Axial image showing width (1), length (2) and screw angle (3).
B: Sagittal image showing length (4) and height (5).
C: Coronal image showing height (6).

RESULTS

The results of the current study showed that the mean left coronal height showed significant gender variation (p 0.010) as it is 9.13 ± 1.32 mm and 8.16 ± 1.08 mm in males and females respectively while the right coronal height was 9.19 ± 1.18 mm and 8.58 ± 1.11 mm among males and females respectively with no significant gender variation (p 0.076). Also, the right and left sagittal height had no significant gender variation (table 1).

On the other hand, the right axial condyle length was 21.76 ± 2.53 mm in males and19.45 2.43 mm in females , the left axial condyle length was 21.53 ± 2.635 mm in males and 19.69 ± 2.928 mm in females which is significantly variant on both right and left sides (p 0.003 and 0.027 respectively) while the sagittal condyle length was gender variant on the right side only (P 0.029 and 0.201 on the right and left side respectively). The right sagittal condyle length was 18.69 ± 1.891 mm and 17.29 ± 2.414 mm in males and females respectively. The left sagittal condyle length was 18.34 ± 2.650 mm and 17.30 ± 2.856 mm in males and females respectively (table 2). The right occipital condyle width was 11.97 ± 1.31 mm and 11.28 ± 0.863 mm in males and females respectively and the left occipital condyle width was 11.84 ± 1.27 mm and 11.41 ± 1.13 mm in males and females respectively with no significant gender variations (0.683 and 0.432 in right and left side respectively) (table 3).

The occipital condyle screw did not show significant gender variation among the studied sample of the Malaysian adult population on either right or left side with p 0.083 and 0.687 respectively. The right occipital condyle screw was 29.47° ± 5.99° and 33.03° ± 7.88° in males and females respectively. The left occipital condyle screw was 31.20° ± 5.12° and 31.85° ± 6.02° in males and females respectively (table 4).

The most common occipital condyle shape among the studied Malaysian adults was the kidney shape (70.8%) followed by the rectangle (10.4%), bullet (10.4%) and oval (8.3%) shape on the right side and nearly same on the left side (table 5).

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Table 1: Gender variations of the occipital condyle height among the Malaysian population

Parameters	Gender	N	Mean (mm)	Std. Deviation	Mean Difference	P-Value	95% C.I.	
							Lower	Upper
RT OCCIPITAL CONDYLE HEIGHT (CORONAL)	MALE	28	9.19	1.181	.613	.076	-.066	1.292
	FEMALE	20	8.58	1.112				
LT OCCIPITAL CONDYLE HEIGHT (CORONAL)	MALE	28	9.13	1.325	.965	**.010**	.238	1.691
	FEMALE	20	8.16	1.089				
RT OCCIPITAL CONDYLE HEIGHT (SAGITTAL)	MALE	28	10.21	1.449	.768	.066	-.053	1.588
	FEMALE	20	9.45	1.309				
LT OCCIPITAL CONDYLE HEIGHT (SAGITTAL)	MALE	28	10.15	1.530	.379	.488	-.713	1.471
	FEMALE	20	9.77	2.233				

Table 2: Gender variations of the occipital condyle length among the Malaysian population

Parameters	Gender	N	Mean(mm)	Std. Deviation	Mean Difference	P-Value	95% C.I.	
							Lower	Upper
RT OCCIPITAL CONDYLE LENGTH (AXIAL)	MALE	28	21.76	2.538	2.310	**.003**	.840	3.781
	FEMALE	20	19.45	2.434				
LT OCCIPITAL CONDYLE LENGTH (AXIAL)	MALE	28	21.53	2.635	1.846	**.027**	.220	3.473
	FEMALE	20	19.69	2.928				
RT OCCIPITAL CONDYLE LENGTH(SAGITTAL)	MALE	28	18.69	1.891	1.401	**.029**	.150	2.652
	FEMALE	20	17.29	2.414				
LT OCCIPITAL CONDYLE LENGTH (SAGITTAL)	MALE	28	18.34	2.650	1.040	.201	-.573	2.653
	FEMALE	20	17.30	2.856				

Table 3: Gender variations of the occipital condyle width among the Malaysian population

Parameters	Gender	N	Mean (mm)	Std. Deviation	Mean Difference	P-Value	95% C.I.	
							Lower	Upper
RT OCCIPITAL CONDYLE WIDTH	MALE	28	11.97	1.316	.683	.048	.005	1.361
	FEMALE	20	11.28	.863				
LT OCCIPITAL CONDYLE WIDTH	MALE	28	11.84	1.271	.432	.231	-.284	1.148
	FEMALE	20	11.41	1.131				

Table 4: Gender variations of the occipital condyle screw angle among the Malaysian population

Parameters	Gender	N	Mean (°)	Std. Deviation	Mean Difference	P-Value	95% C.I.	
							Lower	Upper
RT OCCIPITAL CONDYLE SCREW ANGLE	MALE	28	29.47	5.991	-3.553	.083	-7.582	.477
	FEMALE	20	33.03	7.885				

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LT OCCIPITAL CONDYLE SCREW ANGLE	MALE	28	31.20	5.121	-.655	.687	-3.904	2.595
	FEMALE	20	31.85	6.029				

Table 5: Gender variations of the occipital condyle shape among the Malaysian population

Parameters	Gender	BULLET	KIDNEY	OVAL	RECTANGLE	TOTAL
RT OCCIPITAL CONDYLE SHAPE	MALE	3 (10.7%)	19 (67.9%)	3 (10.7%)	3 (10.7%)	28 (100%)
	FEMALE	2 (10%)	15 (75%)	1 (5%)	2 (10%)	20 (100%)
	TOTAL	5 (10.4%)	34 (70.8%)	4 (8.3%)	5 (10.4%)	48 (100%)
LT OCCIPITAL CONDYLE SHAPE	MALE	2 (7.1%)	20 (71.4%)	3 (10.7%)	3 (10.7%)	28 (100%)
	FEMALE	2 (10%)	15 (75%)	1 (5%)	2 (10%)	20 (100%)
	TOTAL	4 (8.3%)	35 (72.9%)	4 (8.3%)	5 (10.4%)	48 (100%)

Discussion

The use of morphometric trait of the occipital condyles in North Indian skeletal populations was considered in cases of fragmented cranial bases where no other method can be utilized for sex determination (26). Previous cadaveric studies demonstrated variability in anatomical parameters and recommended careful CT scanning and analysis before screw placement (16, 17, 27) beside different researches that studied the racial and gender characteristics of different population. The current research aimed to study the morphologic and the biometric characteristics among the Malaysian population. Ten measurements of the occipital condyle had been studied with the occipital condyle screw angle and the condyle shape comparing between males and females and between right and left sides.

The results of the current study showed that the mean left coronal height showed significant gender variation while the right coronal height did not. Also, the right and left sagittal height had no significant gender variation. On the other hand, the axial condyle length showed significant gender variation on both left and right sides in contrary to the sagittal condyle length which was gender variant on the right side only. The right and left occipital condyle width showed no significant gender variation. Generally, the male measurements are larger than female.

The occipital condyle measurements have been previously studied on 340 condyles that reported the sagittal AP length to be 22.4±2.2 mm (14) while in another study by including 80 condyles, it was measured as 20.3±2.1 mm (11) and it was 17.22±1.67 mm different study included examination of 82 occipital condyles of adult Indians (25). In the current study, the right axial condyle length was 21.76

± 2.53 mm in males and19.45 ± 2.43 mm in females, the left axial condyle length was 21.53 ± 2.635 mm in males and 19.69 ± 2.928 mm in females with significant gender variation on both right and left sides while the sagittal condyle length was gender variant on the right side only. The right sagittal condyle length was 18.69 ± 1.891 mm and 17.29 ± 2.414 mm in males and females respectively. The left sagittal condyle length was 18.34 ± 2.650 mm and 17.30 ± 2.856 mm in males and females respectively. On axial scans, the mean condylar length was 19.62±2.57 mm in one study (25) and was 20.3 ±2.2 mm in another study (14).

The occipitocervical length was 23.9±3.4 mm on the right side and 24 ±3.3 mm on the left side in a Turkish cadaveric morphometry study (28), that is shorter than the Indian population measurements (20.8±2.2 mm on the right side and 19.8±3.1 mm on the left side (25). CT data from 27 fresh-frozen cadaveric Chinese occipitocervical spines showed that the mean length and

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width of the OC are significantly longer in males (22.2 ± 1.7 mm and 12.1 ± 1.0 mm, respectively). The mean screw length (19.3 ± 1.9 mm) also presented significant sex-related differences; male greater than female (29). That difference between the studies confirm the racial characteristics among different populations.

There is wide variability in the measurement of the screw angle in different studies of the axial scans. The current research showed that the occipital condyle screw did not show significant gender variation among the studied sample of the Malaysian adult population on either right or left side. The right occipital condyle screw was 29.47° ± 5.99° and 33.03° ± 7.88° in males and females respectively. The left occipital condyle screw was 31.20° ± 5.12° and 31.85° ± 6.02° in males and females respectively. Among Indians, it was measured as 38°±5.5° (25). A 340 OC were examined with CT scans at Tampa General Hospital, Florida had shown the screw angle was 20.30°
± 4.89° (14). The mean sagittal angle examined by CT from 27 Chinese fresh-frozen human cadaveric occipitocervical spines was 28.0°
± 4.9°. (29). A research in South Carolina university, studied the morphology of the occipital condyle in CT scans of 40 patients with normal cervical spines and results showed that condylar heights (10.8 ± 1.5 mm, range 8.1-15.0 mm), widths (11.1 ± 1.4 mm, range 8.5- 14.2 mm), lengths (20.3 ± 2.1 mm, range 15.4-24.6 mm), and angles (mean 32.8° ± 5.2°, range 20.2°-45.8°) (11).
The most common occipital condyle shape among the studied Malaysian adults in this study was the kidney shape (70.8%) followed by the rectangle (10.4%), bullet (10.4%) and oval (8.3%) shape on the right side and nearly same on the left side. In a study on 50 dry Iranian skulls showed variations of occipital condyle shapes to include kidney like (34.4%), S-like (25.6), triangular (13.3%) oval (10.0%), ring like (7.8%), eight like (6.7%) and deformed (2.2%) shape (30). On studying 404 occipital condyles of 202 dry Turkish skulls, the occipital condyles' shape was classified into 8 types including oval-like condyle (50%), kidney-like condyle (3.5%), S-like condyle (23.2%), eight-like condyle (4.2%), triangle condyle (9.0%), ring-like condyle (4.0%), two-portioned condyle (0.8%) and
deformed condyle (5.5%) (17).
According to the results of this research and the previous researches, the occipital condyle measurements represent ethnic and gender characteristics that can be used for identification in case other tools are not available. The Malaysian population, occipital condyle measurements are different from other races and are generally bigger in males than females with a statistically significant variations in some measurements that can be a gender differentiation point. The most common occipital condyle shape among the studied Malaysian adults is the kidney shape and the least is the oval shape.

References

[1] al-Mefty O , Borba LA , Aoki N , et al. The transcondylar approach to extradural nonneoplastic lesions of the craniovertebral junction.J Neurosurg 1996; 84: 1 – 6.

[2] Junewick J. J. Pediatric craniocervical junction injuries. AJR Am J Roentgenol 2011; 196: 1003 – 10.

[3] Menezes A. H .Craniovertebral junction anomalies: diagnosis and management. SeminPediatrNeurol 1997; 4: 209 – 23.

[4] Vaccaro A. R., Lim M. R., Lee J. Y. Indications for surgery and stabilization techniques of the occipito-cervical junction. Injury 2005; 36 (suppl 2): B44 – 53 .

[5] Finn M. A., Bishop F. S., Dailey A. T. Surgical treatment of occipitocervical instability. Neurosurgery 2008; 63: 961 – 8; discussion 968–9.

[6] Stock G. H., Vaccaro A. R., Brown A. K., et al. Contemporary posterior occipital fixation. J Bone Joint Surg; 2006; 88: 1642 – 1649.

[7] Grob D., Crisco J. J., Panjabi M. M, et al. Biomechanical evaluation of four different posterior atlantoaxial fixation techniques. Spine 1992; 17: 480 – 490.

[8] Hurlbert R. J., Crawford N. R., Choi W. G., et al. A biomechanical evaluation of occipitocervical instrumentation: screw compared with wire fixation. J Neurosurg 1999; 90 (1 suppl): 84 – 90.

[9] Uribe J.S., Ramos E., Vale F. Feasibility of occipital condyle screw placement for occipitocervical fixation: a cadaveric study and description of a novel technique. J Spinal Disord Tech 2008; 21: 540 – 6.

[10] Bekelis K., Duhaime A. C., Missios S., et al. Placement of occipital condyle screws for occipitocervical fixation in a pediatric patient with occipitocervical instability after decompression for Chiari malformation. J NeurosurgPediatr 2010; 6: 171 – 6.

[11] Frankel BM, Hanley M, Vandergrift A, Monroe T, Morgan S, Rumboldt Z (2010) Posterior occipitocervical (C0-3) fusion using polyaxial occipital condyle to cervical spine screw and rod fixation: a radiographic and cadaveric analysis. J Neurosurg Spine 12 (5): 509– 516

[12] La Marca F., Zubay G., Morrison T., et al. Cadaveric study for placement of occipital condyle screws: technique and effects on surrounding anatomic structures. J Neurosurg Spine 2008; 9: 347 – 53.

[13] Uribe J. S., Ramos E., Baaj A., et al. Occipital cervical stabilization using occipital condyles for cranial fixation: technical case report. Neurosurgery 2009; 65: E1216.

[14] Le TV, Dakwar E, Hann S, et al. Computed tomography-based morphometric analysis of the human occipital condyle for occipital condyle-cervical fusion. J Neurosurg Spine, 2011; 15:328-31.

[15] Lee J. O., Buchowski J. M., Lee K. M., et al. Optimal trajectory for the occipital condylar screw. Spine 2012; 37: 385 – 92.

[16] Muthukumar N., Swaminathan R., Venkatesh G. and Bhanumathy S. P. A morphometric analysis of the foramen magnum region as it relates to the transcondylar approach. ActaNeurochir (Wien) 2005; 147:889– 895.

[17] Naderi S., Korman E., Cıtak G., G¨uvencer M., Arman C., Senoglu M., Tetik S. and Arda M. N. Morphometric analysis of human occipital condyle. Clinical Neurology and Neurosurgery 2005; 107: 191–199.

[18] Attalla S. M., Ads H. O., Oo T., Abdalqader M. A., Ramanathan P. and KhairulZaman K. Gender and Race Determination of the maxillary sinus among Malaysian Population by Computed Tomography. IJMTLM 2020; 23 (1-2): 5- 9. DOI:10.5958/0974-4614.2020.00002.9

[19] Ibrahim A., Attalla S. M., Alias A., Swarhib M., Abu Bakar S.N., Das S., and Nor F.M. Osteometric analysis of supraorbital foramen and notch in Malaysian crania. Asian Journal of Pharmaceutical and clinical research (AJPCR 2018; 11 (10): 509 – 512. DOI: 10.22159/ajpcr.2018.v11i10.26508

[20] Attalla S. M., Kumar K.A. and Hussain N. Application of "Iannarelli system" on the Malaysian young adults. IJMTLM 2020; 23 (1-2): 1- 4. DOI:10.5958/0974-4614.2020.00001.7

[21] Attalla S. M., Ruhi S., Shebl H. and Khalil P. M. Inter-racial and intra-rarcial gender characterization of eye shape among malaysian population in shah alam, Malaysia. IJMTLM 2020; 23 (1-2): 16- 19. DOI:10.5958/0974-4614.2020.00004.2

[22] Attalla Sohayla M. and AinHajarNurul. Sex Characterization by Cranial Measurements among Malaysian Races in Section 13 Shah Alam, Malaysia. IJMTLM 2019; 22 (3-4): 1 – 5. DOI : 10.5958/0974-4614.2019.00050.0

[23] Attalla S. M. and Deri N. M. Racial identification of head shape by cephalic index in the Malaysian population in section 13 ShalAlam Malaysia. International Journal of Medical Toxicology & Legal Medicine (IJMTLM) 2018; 21 (3-4): 8 – 10. DOI : 10.5958/0974- 4614.2018.00016.5

[24] Attalla S. M., AbdelKader M. A. and Khalili P. M. Sexual dimorphism in facial characteristics among Malaysian ancestries (Malay/ Chinese/ Indian) in section 13 Shah Alam. International Journal of Medical Toxicology & Legal Medicine (IJMTLM) 2018; 21 (3- 4): 125 - 129. DOI: 10.5958/0974-4614.2018.00049.9

[25] Srivastava A., Nanda G., Mahajan R., Nanda A., Mishra N., Karmaran S., Batra S., Chhabra H.S. Computed Tomography-Based Occipital Condyle Morphometry in an Indian Population to Assess the Feasibility of Condylar Screws for Occipitocervical Fusion. Asian Spine J 2017;11 (6):847- 853. https://doi.org/10.4184/asj.2017.11.6.847

[26] Kumar A. and Nagar M. Human Adult Occipital Condyles: A Morphometric Analysis. RRJMHS 2014; 3 (4): 112 – 116.

[27] Guidotti A. Morphometrical considerations on occipital condyles. AnthropolAnz. 1984; 42:117–119.

[28] Ozer M. A., Celik S., Govsa F., Ulusoy M. O. Anatomical determination of a safe entry point for occipital condyle screw using three-dimensional landmarks. Eur Spine J 2011; 20:1510-7.

[29] Zhou J., Espinoza Orías A. A., Kang X., He J., Zhang Z., Inoue N. and An H. S. CT-based morphometric analysis of the occipital condyle: focus on occipital condyle screw insertion. J Neurosurg Spine. June 2016. DOI: 10.3171/2016.4.SPINE151431.

[30] Bayat P., Bagheri M., Ghanbari A. and Raoofi A. Characterization of occipital condyle and comparison of its dimensions with head and foramen magnum circumferences in dry skulls of Iran. Int. J. Morphol. 2014; 32 (2): 444 - 448.