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Measurements of the Carotid Canal in Skulls from Anatolia

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Key Words
Carotid canal
Measurement
Skull base

Abstract
Since widespread applications of microsurgery are being employed for aneurysms, clival tumors, etc., precise knowledge of the skull base measurements has become vital, and a study of 307 adult skulls – 130 female and 177 male – has been undertaken. Measurements were made between the landmarks chosen in accordance with the study of Lang in 1983 and our average values were similar to his series, being closer to his female data. There was no significant difference between the right and left sides of the skull.

Introduction

The canalis caroticus (CC) is placed in the pars petrosa of the os temporale and it transmits the arteria carotis interna (ACI). The apertura externa canalis carotici (AECC) is found on the lower surface of the pars petrosa of the os temporale, behind the foramen lacerum and sulcus tubae auditivae and anterior to the fossa jugularis and foramina jugularia [Berkoviz and Moxham, 1988; Williams and Warwick, 1992]. Beginning from the AECC, the CC runs upward for a distance of 1 cm and then bending on itself at almost a right angle, the canal turns forward and medially, directed up to the apex of the pars petrosa for 2–3 cm. Here it comes to an end, forming the apertura interna canalis carotici (AICC). This opening is found in front of the foramen lacerum, intracranially. The ACI is separated from the CC walls by perivascular tissues and the plexus venosus caroticus internus [Sprinzl et al., 1992].

Measurements of the adult skull base has been performed by only a few investigators [Rutz, 1975; Lang et al., 1983; Lang and Schreiber, 1983; Lang and Hack, 1985]. Initially, Graf Spee studied the prenatal CC in 1896, demonstrating that it transmits the ACI within its internal curvature. He noted that the anteroinferior wall of the CC is occasionally missing, just like the tuba auditiva which is not a closed tube. Platzer [1956] has studied the AICC while Rutz in 1975 has measured the adult CC size together with angular measurements of its internal bend. Imaging techniques such as computerized tomography (CT) and magnetic resonance tomography (MRT) have revealed

Abbreviations used in this paper:
ACI = Arteria carotis interna; AECC = apertura externa canalis carotici; AICC = apertura interna canalis carotici; CC = canalis caroticus; CT = computerized tomography; DSA = digital substraction angiography; MRT = magnetic resonance tomography.

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many normal and pathological findings of the foramina of the skull.

Microsurgery is being employed for aneurysms, clival tumors, etc. [Lang and Hack, 1985], therefore, precise knowledge of the skull base anatomy has become vital [Berlis and Putz, 1992]. In one of our recent studies concerning the assessment of skull asymmetries, the importance of skull base foraminal measurements has become apparent [Gözil et al., 1996]. The present study was planned to inform neurosurgeons and neuroradiologists about the comparative measurements of skull base. The 'CC' was chosen as the landmark since it is the most vital and the most easily visualized structure on MRT angiography and digital substraction angiography (DSA). The measurements were performed on skull collections originating from Anatolia – available to our group – and the results were simply compared to the data from other studies.

Materials and Methods

In this study 307 dry adult skulls were used, 130 of them female and 177 male. The skulls were obtained from the collections of Gazi University Medical Faculty, Department of Anatomy and Ankara University Faculty of Letters, Department of Physical Anthropology and Paleoanthropology. They were found to have a normal distribution when the symmetry and length-width index of the skull was taken into account [Gözil et al., 1996].

Both sliding and spreading calipers were used [Brothwell, 1981] for the measurements performed extracranially. The obtained values were classified according to gender and lateralization and given as mean ± SEM (table 1). The landmarks and measurements were chosen in accordance with the study of Lang and Schreiber [1983] (fig. 1): (A) external length of CC (the distance between AECC and AICC); (B) long diameter of AICC; (C) short diameter of AICC; (D) the distance from medial border of AECC to midsagittal plane; (E) the distance from lateral border of AECC to midsagittal plane; (F) the distance between lateral border of AECC and crista supramastoidea; (G) the distance between lateral border of AECC and porus acusticus externus (sutura tympanomastoidea).

In various studies, the horizontal part of the CC was named 'pars petrosa ascendens' and the second transverse portion 'pars petrosa transversalis'. Formal names of these parts could not be found in *Nomina Anatomica* [Lang et al., 1983]. Since our measurements were performed extracranially, measurements of the pars petrosa ascendens and pars petrosa transversalis were not included. The compared values were statistically assessed using ANOVA and Student's t test.

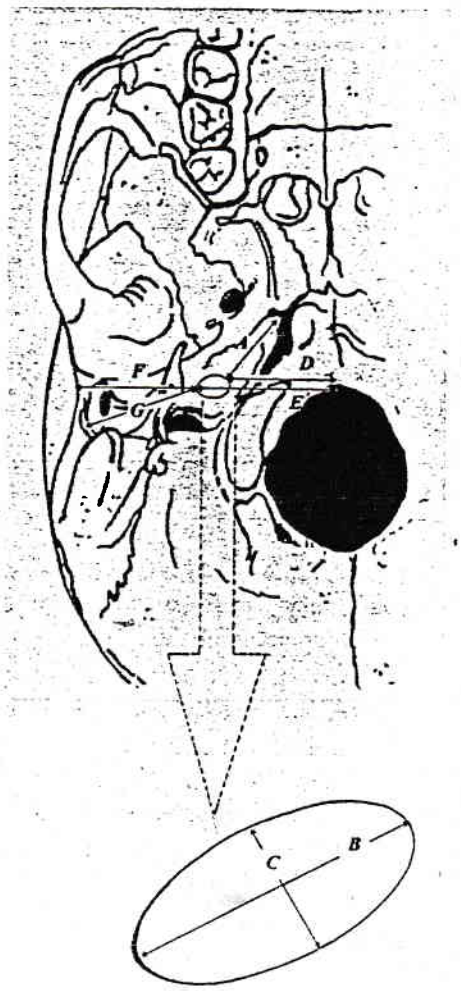


Fig. 1. Landmarks and measurements were chosen in accordance with the study of Lang and Schreiber [1983]: A = external length of canalis caroticus (the distance between the apertura externa canalis carotici and apertura interna canalis carotici); B = long diameter of apertura interna canalis carotici; C = short diameter of apertura interna canalis carotici; D = distance from medial border of apertura externa canalis carotici to midsagittal plane; E = distance from lateral border of apertura externa canalis carotici to midsagittal plane; F = distance between lateral border of apertura externa canalis carotici and crista supramastoidea; G = distance between lateral border of apertura externa canalis carotici and porus acusticus externus (sutura tympanomastoidea).

Results

In our study, we determined the aforementioned lengths in 130 female and 177 male adult skulls, separately on the right and left sides (table 1). In a literature survey, only Lang and Schreiber's [1983] series was found to be noteworthy with measurements of the CC. Therefore results of our measurements were compared only to their data (table 1), although they had assessed these measurements mostly among early newborn and pediatric age groups. All the minor differences between the values were statistically nonsignificant ($p<0.05$).

Table 1. Values obtained from adult skulls compared to Lang's series

	Lang's series				Our series							
					female				male			
	right		left		right		left		right		left	
	$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM
a	–	–	–	–	10.95	±2.55	11.26	±2.22	11.51	±2.53	11.29	±2.64
b	6.59	±0.74	6.62	±0.10	6.68	±1.18	6.30	±1.05	6.82	±1.56	6.50	±1.46
c	5.08	±0.20	5.20	±0.34	4.59	±0.87	4.33	±0.91	4.86	±2.34	4.60	±1.05
d	20.50	±0.50	24.25	±0.75	25.01	±3.59	24.92	±2.45	25.63	±3.60	25.67	±2.88
e	28.25	±0.75	32.25	±0.75	30.41	±2.96	30.47	±2.70	31.53	±2.99	31.33	±2.64
f	28.24	±0.28	28.60	±0.29	29.77	±3.12	30.13	±2.74	31.16	±2.62	31.36	±2.87
g	22.39	±0.27	22.81	±0.26	22.72	±3.42	22.90	±3.45	23.50	±3.12	24.29	±3.16

Comparison with Lang's series of our measurements classified according to gender and lateralization, given a mean ± SEM.

Discussion

Spee reported bilateral absence of the anteroinferior wall of CC for the first time in 1896. The absent or deficient inferior wall of CC is an important variation that can give rise to complications through skull base surgery [Lang et al., 1983; Lang and Schreiber, 1983; Lang and Hack, 1985; Quint et al., 1992]. Sharma [1993] has reported only one case of absent inferior wall among 325 cases; while in another series 5 cases of deficient inferior wall was found among 98 adult skulls. In such cases, the ACI is found in a sulcus and in one case, this sulcus was not 'S' shaped but straightly placed near the corpus of the os sphenoidale [Rutz, 1975; Lang et al., 1983]. In our study, the inferior wall was found to be deficient in 5 cases among 307 skulls.

The results of our measurements performed upon 307 skulls with a normal distribution [Gözil et al., 1996] were similar ($p<0.05$) to Lang's series, our average values being closer to the female data of his series. The possible source of such a nonsignificant difference may be the fact that Lang and Schreiber's series included mostly newborn and pediatric age groups as compared to our adult material. In general, there was not a significant difference between the right and left sides of the skull ($p<0.05$).

Concerning our results, the possible advantages for the neurosurgeons and neuroradiologists are precautionary information about the precise distance of CC from various landmarks encountered throughout skull base surgery and the incidence of a deficient inferior wall of CC.

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