

## Research Article

# Morphometric Evaluation of the Anterior Condylar Canals in Dry Human South Indian Skulls

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**How to cite:** Harikrishnan R , Morphometric Evaluation of the Anterior Condylar Canals in Dry Human South Indian Skulls – Research Article . Int J Cranio Maxillofac Surg Rehab Volume 2022, Article ID 22147326, 8 pages.

Received:12/01/22

Accepted:31/01/22

Web Published:16/02/22

## Abstract

**Introduction:** The anterior condylar canal is one of the most important foramina present in the skull. It transmits the hypoglossal nerve, a meningeal branch of ascending pharyngeal artery, and an emissary branch. This canal is important to anatomists, anthropologists, forensic experts, and clinicians and has been of considerable interest in the field of neurosurgery and research workers especially due to their racial and regional variations.

**Aim:** To evaluate the morphogenic difference of the anterior condylar canals in south Indian skulls.

**Materials and Methods:** The present morphometric study was done on 30 unsexed dry human cranial cavities. Various dimensions like depth, height, and width of both the right and left anterior condylar canal were measured using a digital vernier caliper. All data collected were tabulated and statistically analyzed.

**Results:** The average depth were  $9.1 + 0.48$  mm and  $9.6 + 0.46$  mm, the average height were  $5.93 + 0.22$  mm and  $6.16 + 0.19$  mm and the average width of the anterior condylar canals was calculated to be  $5.63 + 0.28$  mm and  $6.16 + 0.30$  mm for the left and right side respectively. On paired sample T-test analysis, there was no statistical significance between left and right side depth and height but width between both side canals showed statistical significance.

**Conclusion:** Knowledge regarding these kinds of anatomical variations is important in the case of treatments and surgeries. The data recorded from this study will aid in various aspects of anthropology, forensics, surgery, and future research.

**Keywords:** Anterior condylar canal, hypoglossal canal, dry skulls, innovative, morphometry, cranial base foramen

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## **INTRODUCTION**

The anterior condylar canal or better known as the hypoglossal canal is a paired bony passage that is directed anterolaterally and located above and anterior to the occipital condyles [1]. It is a foramen in the occipital bone of the skull, above the occipital condyle at its junction of anterior one-third [2,3]. The hypoglossal canal is surrounded by cortical bone and transmits the hypoglossal nerve, the meningeal branch of ascending pharyngeal artery, and an emissary branch of ascending pharyngeal artery [2,4].

This canal is important to anatomists, anthropologists, forensic experts, and clinicians and has been of considerable interest in the field of neurosurgery and research workers especially due to their racial and regional variations. Studies on cadavers have been conducted to find the anatomical variability of the hypoglossal canal. The canal is a region of the skull base which is involved in numerous pathologies. Proper knowledge of the canal anatomy, its related structures, and neural and vascular structures is important for the surgery of lesions involved in this area [5]. The hypoglossal canal is surrounded superiorly by the jugular tubercle, superolateral by the jugular foramen, laterally by the sigmoid sinus, and inferiorly by the occipital condyle [6].

The hypoglossal canal is formed during the embryological stage of development and sometimes leads to the formation of more than two canals formed as the occipital bone is formed [7]. The canal has been observed to have variations between gender and race and species. Studies have shown that the size of the hypoglossal canal was observed to be bigger in males than in females. The dimension of the right canal is bigger than the one on the left. Unilateral and bilateral double hypoglossal canals were observed in various cases [8].

Lesions involving the hypoglossal canal are rare and usually benign in nature. Some lesions include hypoglossal nerve schwannomas, posterior cranial fossa meningiomas, and jugular tympanic paragangliomas. Surgical intervention in these areas would depend on multiple factors such as the size and type of the tumor, the patient's age, symptoms, and comorbid conditions [9]. The canal is directed anterolaterally, surrounded by the occipital condyles inferiorly, the sphenoid portion of the clivus superomedially, and the jugular foramen and jugular process of the occipital bone laterally [1].

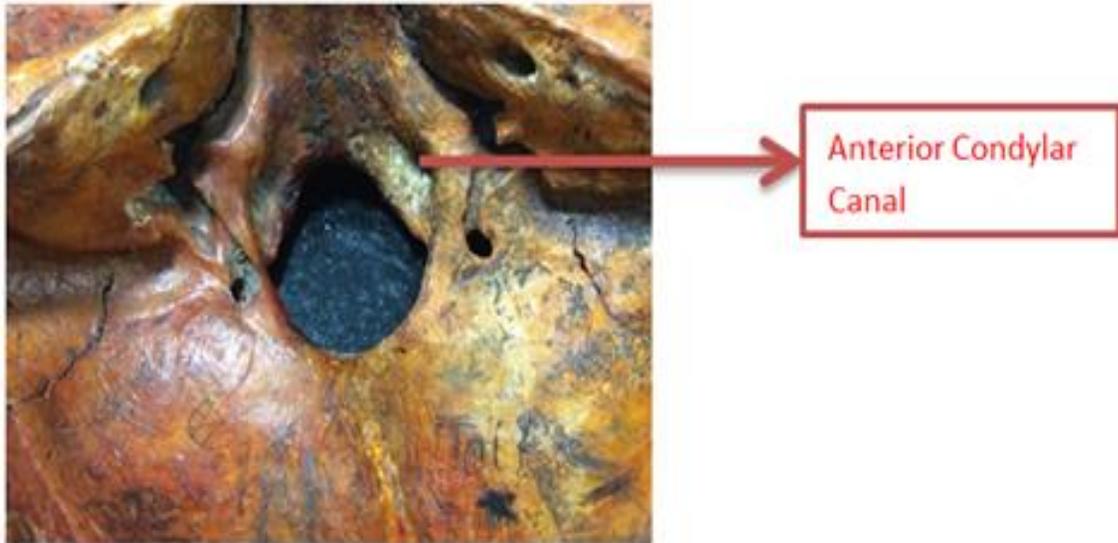
Three distinct surgical approaches can be used by surgeons that permit access to the hypoglossal canal region and its structures. They help in the exposure and resection of extradural, intradural, and transdural lesions that involve the canal. The three approaches include Pre and postauricular infratemporal fossa approach to the extradural hypoglossal canal, far lateral craniotomy, and transjugular craniotomy. All three techniques are complex and lengthy procedures [10]. While drilling into the occipital bone the surgeon needs to anticipate the possible depth and direction of the hypoglossal canal, hence preoperative morphometry of the canal would help select the surgical approach that would be appropriate [11].

Recent research about the hypoglossal canal has been focused on determining the evolution of speech in humans. Comparisons of the size and shape of the canal have been made between hominid skulls and modern-day human skulls to do so [12]. It is proposed that humans have speech abilities due to the relatively larger size of the hypoglossal canal, which would correspond to a large hypoglossal nerve, the cranial nerve that controls the motor function of the tongue.

The study of this canal will help in the diagnosis of tumors that are found at the base of the skull. Most studies of this canal would revolve around the development of safe drilling techniques to conduct surgery on that area of the brain. The landmarks and the dimensions of the condylar canal can be helpful in times of surgery and also helps doctors decide on treatment plans. It is a must to know the bony structure, dimensions, and variations before any procedure. It is also one of the tools used in forensics. The neurovascular relationship in this study makes it quite important to learn and understand the morphometric variations seen. It will also be very helpful in surgical and forensic aspects as well. Our team has extensive knowledge and research experience that has translated into high-quality publications [13-32]. The current study aims to evaluate the morphogenic difference in the anterior condylar canals in south Indian skulls.

## MATERIALS AND METHODS

The present morphometric study was done on 30 unsexed dry human cranial cavities obtained from the Department of Anatomy, Chennai. The skulls were observed for any damage and the cranial cavities only in good condition were selected for the study (Figure 1). Various dimensions like depth, height, and width of both the right and left anterior condylar canal were measured using a digital vernier caliper. All data collected were tabulated and statistically analyzed using the SPSS version (23) and paired T-test was performed.



**Figure 1: Location of the anterior condylar fossa**

## RESULTS

From Table 1 it is seen that the average depth was  $9.1 \pm 0.48$  mm and  $9.6 \pm 0.46$  mm, the average height was  $5.93 \pm 0.22$  mm and  $6.16 \pm 0.19$  mm, and the average width of the anterior condylar canals was calculated to be  $5.63 \pm 0.28$  mm and  $6.16 \pm 0.30$  mm for the left and right side respectively. The significance of depth between the right and left side of the canal was calculated using a paired sample t-test and the  $t$ -value is -1.140. The  $p$ -value is .264. The result is *not* significant at  $p < .05$ .

The significance of height between the right and left side of the canal was calculated using a paired sample 't' test and the  $t$ -value is -1.165. The  $p$ -value is .254. The result is *not* significant at  $p < .05$ . The significance of the width between the right and left side of the canal was calculated using a paired 'sample to test and the  $t$ -value is -2.866 The  $p$ -value is .008. The result is significant at  $p < .05$

**Table 1: Range, Average, and standard error for depth, height, and width measurements in mm of right and left anterior condylar canal (N=30).**

N=30	Depth		Height		Width	
	Left	Right	Left	Right	Left	Right
Range in mm	4.2 - 16.7	5.6 - 13.4	4.1 - 8.8	4.4 - 8.7	3.2 - 8.4	3.2 - 8.7
Average in mm	9.1	9.6	5.93	6.16	5.63	6.16
SE	0.48	0.46	0.22	0.19	0.28	0.30
P value*	0.264 ( $p < 0.05$ )		0.254 ( $p < 0.05$ )		0.008 ( $p < 0.05$ )	

\*paired sample t-test

## DISCUSSION

Studies done on cadavers and dry skulls have been conducted to find the various anatomical variabilities in structures such as the anterior condylar canal in different races. The anterior condylar canal is present in the region of the skull that is involved in numerous pathologies and it is important to have proper knowledge regarding the morphology, morphometry, and relations of the canal. The hypoglossal canals are divided by connective tissues or bone as they are generally thought to represent the fusion of three or four formerly separated vertebrae in the fetal period that result in basioccipital bone formation [33]. There have been studies conducted that stated that the morphology of the canal differed between genders [34]. Size asymmetry was seen to be a common finding in the majority of studies conducted regarding the hypoglossal canal. From the present study, it was observed that there was no difference in depth and height between the right and left hypoglossal canal but the width showed a statistically significant difference between both sides and the right canal width was larger when compared to the left hypoglossal canal.

The present study stated that the average depth of the left and right anterior condylar canals were recorded to be 9.1 mm and 9.6 mm respectively. This is the distance between the extracranial and intracranial opening of the hypoglossal canal. A similar study done in North India stated that the distance between the extracranial and intracranial opening of the canals was seen to be greater in the right hypoglossal canal as compared to the left [1]. The distance that was recorded in this particular study was an average of 0.63 on the right and 0.59 on the left. A study done by Hadley et al in 2004 stated that the average length of the canal was seen to be 11.2mm [35]. Berlis A et al stated the average length of the hypoglossal canal to be 7.78mm [36].

The average height of the left and right canals is 5.93 mm and 6.16mm respectively and the average width was measured to be 5.63 mm and 6.16mm for the left and right canals respectively.

A study done in Nigeria, measured the length and width of 40 dry skulls, the average length was recorded to be 12.35mm and 12.57mm on the left and right sides, and the average width was recorded to be 14.24mm and 10.56mm [37]. Vinay et al [38] concluded with similar findings as compared to the present study, the average length of the left and right hypoglossal canals were measured to be 12.5mm and 12.6mm respectively. Muthukumar et al 2005 stated in their study that the average length of the hypoglossal canal was 12.6mm [39].

The anterior condylar canal is a constant entity in the condylar fossa and is absent in only a few cases, which makes the structures passing through it clinically significant. It is observed that if the width of the canal is more, the canal may also transmit the emissary vein, accompanying the hypoglossal nerve. These emissary veins are clinically significant as they connect intracranial venous sinuses with the extracranial veins [11]. The hypoglossal canal plays a good role in forensics as well [40]. Studies have shown that racial differences can be determined with the help of these canals. It has been observed in a study involving the Japanese population which detected the presence of a “double hypoglossal canal” using multidetector computed tomography [33]. The study was limited to only 30 skulls. In the future, more skulls and the relative position of the canal from other anatomical structures can also be included.

## CONCLUSION

This study has investigated the various dimensions of the hypoglossal canal which included the length, width, and depth of the canal on both sides of the skulls. It had concluded that there was a significant difference present only between the width of the right and left canals. The data recorded from this study will aid in various aspects of anthropology, forensics, surgery, and future research.

**Financial support and sponsorship** - Nil

**Conflicts of interest** - There are no conflicts of interest

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