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OSTEOTIC VARIATIONS IN THE PARACONDYLAR REGION OF ADULT HUMAN SKULLS: INCIDENCE AND CLINICAL RELEVANCE

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ABSTRACT

Background: In the paracondylar region(lateral to the occipital condyles)there might be morphological variation in the form of an anomalous foramina. This anomalous foramina may represent the course of an emissary vein in absence of posterior condylar canal or an aberrant course. **Material & Method:** 82 dry adult skulls (164 sides), of Indian origin and of both the sexes formed the basis for this study. The region anterior, posterior and lateral to the occipital condyles was carefully examined for the presence of foramina. Complete foramina were only considered for this study. The patency was ascertained by passage of a probe through it. **Results:** paracondylar foramina was observed in 12.1% specimens, in 10.9% it was predominantly located on the left side and in 1.2% it was bilateral. No right sided paracondylar foramina was observed. Unilateral left sided Double hypoglossal canal was seen in 4.8% specimens. Posterior condylar canal was present in 9.7% out of which 6.0% were on the left side exclusively and 3.6% bilateral in position. **Conclusion:** Misinterpretation may occur as neoplasm or an abnormal lymph node during radiodiagnosis Surgical procedures in this area such as paracondylar approach and far lateral supracondylar approach could be impacted upon by this. **Keywords:** Paracondylar Foramina; Double Hypoglossal Canal; Posterior Condylar Canal; Occipital Condyles; Skull.

INTRODUCTION

Located on the cranial base, anterior to the occipital condyles, is the anterior condylar canal, also known as the hypoglossal canal. This canal serves as a passage for the hypoglossal nerve, the meningeal branch of the ascending pharyngeal artery, and an emissary vein that connects the basilar plexus to the internal jugular vein. In some instances, this canal may be partially or completely divided by a bony spicule. Situated posterior to the occipital condyles is the condylar fossa, which accommodates the superior articular facet of the atlas. Within this fossa, there may be foramina referred to as posterior condylar foramina, which can be either complete or partial. When these foramina are open, they allow the passage of an emissary vein and associated nerves. The emissary vein, known as the posterior condylar vein, links the sigmoid sinus with the suboccipital venous plexus. It also has anterior connections with the jugular bulb or vein found in the hypoglossal canal and posterior connections with the vertebral venous plexus located in the condylar fossa, while the nerves supply the dura mater of the posterior cranial fossa. Notably, variations may present as grooves or foramina in the paracondylar

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region, which is lateral to the occipital condyles, and these variations warrant documentation. This morphological diversity serves as the foundation for this study.

MATERIALS AND METHODS

A total of 82 dry adult skulls (164 sides), of Indian origin and of both the sexes were obtained from the Osteology section of Anatomy Department. For the purpose of the study equipments like probe, digital vernier caliper, measuring tape,and digital photography camera were used. Skulls in detoriated state were discarded. The region anterior, posterior and lateral to the occipital condyles was carefully examined for thepresence of foramina. Complete foramina were only considered for this study. The patency wasascertained by passage of a probe through it. The positions of these foramina were also noted inthe posterior cranial fossa. Digital vernier caliper was used to measure the transverse diameter of the anomalous foramina.

RESULTS

Among the 82 skulls examined, anomalous foramina were identified in 10 specimens within the area between the occipital condyles and the jugular foramen. Of these, 9 skulls exhibited the foramina unilaterally on the left side, while 1 skull displayed bilateral foramina. The transverse diameter of these foramina ranged from 2 to 3 mm, with all foramina opening into the posterior cranial fossa, positioned posterolateral to the jugular foramen, within the groove for the sigmoid sinus. Notably, unilateral paracondylar foramina on the right side were not detected in any of the skulls. Additionally, a double hypoglossal canal was found in 4 skulls, located unilaterally on the left side, with a transverse diameter of 4 mm. The results are summarized in Table 1.

Figure 1: Bilateral patent paracondylar foramina

Table 1: Incidence of osteotic variants.

		OSTEOTIC VARIANT (n=82)					
		Paracondylar Foramina		Double Hypoglossal Canal		Posterior Condylar Canal	
		Number	Percentage	Number	Percentage	Number	Percentage
		10	-12.10%	4	-4.80%	8	-9.70%
Unilateral	right	-		-		-	
	left	9	-10.90%	4	-4.80%	5	-6.00%
Bilateral		1	-1.20%	-		3	-3.60%

DISCUSSION

Among the 82 skulls examined, 10 (12.1%) exhibited complete anomalous foramina located

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between the occipital condyles and the jugular foramen. In contrast, Tuli *et al.* reported a significantly higher incidence of 19.4%, with three of those skulls also displaying a patent posterior condylar canal. Hollinshead noted that the posterior condylar canal opens at the groove for the sigmoid sinus, situated posterolaterally to the jugular foramen within the posterior cranial fossa. The anomalous foramina in this study were found to open at the same site in the posterior cranial fossa, suggesting that they may serve as an additional pathway for the drainage of intracranial veins into the extracranial venous system. In seven skulls, only patent anomalous foramina were identified in the paracondylar region, with the posterior condylar canal absent. This finding aligns with the research conducted by Manjunath, who introduced the term "paracondylar foramina." Such foramina indicate

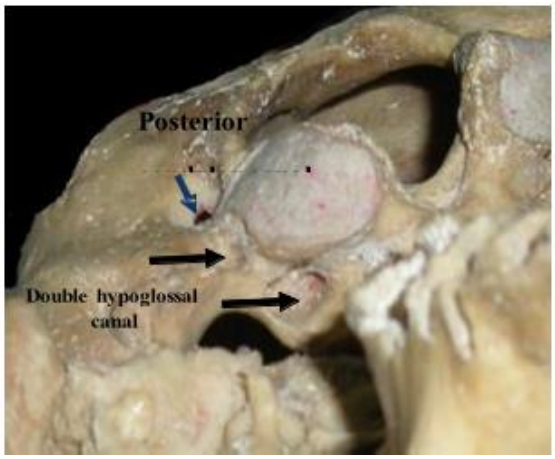

Figure 2: Double hypoglossal canal with Posterior

Table 2: Comparison of occurrence of double hypoglossal canal in different studies. condylar canal.

AUTHOR	PERCENTAGE
De Francisco *et al.* 1990	19.70%
Bhullar *et al.* 1998	28.12%
Wysocki *et al.* 2004	43%
Zaidi *et al.* 2011	12.50%
Jasbir *et al.* 2012	6.00%
Roopali *et al.*2013	28%
Rao *et al.* 2013	2%
Present study	1.20%

an abnormally placed posterior condylar canal or an abnormal course of the posterior condylar emissary vein. Unilateral paracondylar foramina was present 9 skulls (10.9%), this is consistent with 7.6% of Tuli *et al.*[3]. Bilateral paracondylar foramina was observed in 1 skull (1.2%) (Fig 1),this contradicts the study by Tuli *et al.* (11.8%)

In four cases (4.8%), a double hypoglossal canal was identified on the left side. This anatomical variation exhibits significant variability in terms of geographical and racial distribution, as demonstrated by the documented instances in the existing literature (see Table 2). Typically, the hypoglossal canal is positioned anterior to the occipital condyles, extending laterally and anteriorly from the posterior cranial fossa. It serves as a conduit for the hypoglossal nerve, the meningeal branch of the ascending pharyngeal artery, and an emissary vein that connects the intracranial basilar plexus to the extracranial internal jugular vein [6]. The canal may be partially or completely divided by a bony spicule. The hypoglossal nerve arises from rootlets

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attached to the anterolateral sulcus of the medulla and subsequently travels laterally behind the vertebral artery in two bundles, which perforate the dura mater separately at the hypoglossal canal in the occipital bone. After passing through the canal, these bundles merge to form a single structure. From an embryological perspective, the nerve develops from multiple segments, and a failure in the fusion of the two bundles may lead to the canal being divided into two (see Fig 2).

CONCLUSION

The occurrence of paracondylar foramina is relatively rare; however, understanding this anatomical feature is crucial from both surgical and radiological perspectives. Surgical techniques in this region, including the paracondylar approach, which navigates laterally to the occipital condyles, as well as the far lateral supracondylar approach, may be influenced by this anatomical variation. Such variations have the potential to be misinterpreted in radiological assessments. Although there have been no clinically documented cases, the presence of a double hypoglossal canal may increase the risk of hypoglossal nerve entrapment within the occipital bone during the ossification process, potentially resulting in changes to tongue movement and speech.

Conflicts of Interests: None

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