Section: Anatomy

Original Research Article

BRIDGING TRAIT VARIATIONS OF THE HYPOGLOSSAL CANAL IN DRY SKULLS AND HIGH RESOLUTION COMPUTED TOMOGRAPHIC S

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Abstract

Background: The hypoglossal canal is a permanent structure of the human skull that varies in form. Some changes include canal duplication and bridging. This study provided the incidence and classification of bridging trait variations of the hypoglossal canal in the South Indian population.

Objective: Detailed analysis of bridging trait variations of the hypoglossal canal in dry skulls and high resolution computed tomographic scans was done.

Materials and Methods: In 70 dry skulls, bridging trait variations of the hypoglossal canal were observed and classified. In 30 high resolution computed tomographic images of brain, hypoglossal canal were viewed in axial, coronal and sagital plane with multiplanar reconstruction and its bridging trait variations were observed. **Result:** In 70 dry skulls, 65.71% of canals were observed as simple canal (Type I) without any evidence of bridging. 12.86%, 7.86%, 11.43%, 1.43%, and 0.71% of hypoglossal canals showed type IIA pattern, type IIIA pattern, type IVA pattern, type IVB pattern, and type V bridging pattern respectively. Type IIB and IIIB types of pattern were not observed on both side. The osseous spine and canal bridging were more frequently observed at inner orifice of hypoglossal canal in the posterior cranial fossa than at outer orifice of canal at the base of the skull.

In 30 computed tomographic images of brain, 73.5% of canals were observed as simple canal (Type I) without any evidence of bridging. 16.65% and 10% of hypoglossal canals showed type IIA pattern and type IVA pattern respectively. The hypoglossal canal with bridging at outer orifice were not observed in CT images. **Conclusion:** Molecular, environmental, and ethnic factors all influence the bridging pattern of the hypoglossal canal. Anthropologists, forensic experts, radiologists and neurosurgeons all value precise classification of bridging pattern.

INTRODUCTION

The hypoglossal canal lies at the junction of the anterior one-third and posterior two third of the occipital condyle. It lies slightly above and anterolateral to the foramen magnum and is also known as anterior condylar canal. It extends anterolateral from its inner orifice in the posterior cranial fossa to its outer orifice at the base of skull. The canal transmits the hypoglossal nerve, a meningeal branch of ascending pharyngeal artery, and an emissary vein from the basilar plexus internally to the internal jugular vein externally. The hypoglossal nerve supplies entire muscle of tongue.

An embryo has been described to consist of 40 to 44 pairs of somites. Four somites situated rostral to the first cervical nerve are designated as occipital somites or pre-cervical somites. The centre of these somites fuses to form the basi occiput.[1-4]

The amalgamation of intervertebral foramina of these occipital somites forms the hypoglossal canal. This is the embryological viewpoint behind bridging of hypoglossal canal incompletely or completely by bony spicules. Molecular, environmental, and racial factors also decide the bridging pattern of this canal. So, the bridging pattern of this canal is subjected to regional and racial variations. The lesions of the hypoglossal canal are usually benign, and they are

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hypoglossal nerve schwannoma, posterior fossa meningioma, and jugulotympanic paraganglioma.[2,4,5]

The detailed knowledge of the bridging pattern of the hypoglossal canal is essential for neurosurgeons in the surgical interventions of the above-said conditions by trans condylar, supracondylar, and lateral suboccipital approach. The complete analysis of bridging trait variations of the hypoglossal canal is of great importance for radiologists to differentiate normal from abnormal canal in Computed tomographic images. For anthropologists and forensic experts to understand this canal's racial and regional variations.[2,4,6,7] The variations in the bridging trait of the hypoglossal canal are because of its embryonic development process. The incidence of variation is different among the different populations.[2,3,6]

Thus, the present study evaluated a detailed analysis of bridging trait variations of the hypoglossal canal in human adult dry skulls. This study will provide the incidence and classification of bridging trait variations of the hypoglossal canal in the south Indian population.

MATERIALS AND METHODS

The present study was an observational study conducted on the South Indian population. Data were collected from the dry skulls available in the anatomy department of PSG IMS & R and from the retrospective computed tomographic images of the brain available in PACS of PSG Hospital. We have collected data from 70 dry skulls and 30 CT images of the brain. Seventy human adult dry skulls from the anatomy department were chosen for the study. The skulls with broken posterior cranial fossa and occipital condyle were excluded from the study. In 70 dry skulls, bridging trait variations of the hypoglossal canal were observed and classified.

In 30 retrospective computed tomographic images of the brain, the hypoglossal canal was viewed in axial, coronal, and sagittal planes with multiplanar reconstruction, and its bridging trait variations were observed.

Classification of Bridging Trait Variations of The Hypoglossal Canal

Types	Definition
I	Simple canal
IIA	One osseous spine at the inner orifice of the canal
IIB	One osseous spine at the outer orifice of the canal
IIIA	Two or more osseous spine at the inner orifice of the canal
IIIB	Two or more osseous spine at the outer orifice of the canal
IVA	Complete osseous bridging at the inner orifice of the canal
IVB	Complete osseous bridging at the outer orifice of the canal
V	Complete osseous bridging along the whole canal

RESULTS

In High Resolution Computed Tomographic Scans (HRCT)

Bridging trait variations indicated 70%, 16.6%, and 13.4% right side canal in HRCT for type I, IIA, and IVA, respectively. While bridging trait variations indicated 76.7%, 16.7%, and 6.6% left side canal in HRCT for type I, IIA, and IVA, respectively [Table 1].

Table 1: Frequencies & Percentage of Bridging Trait Variations in HRCT images

	Right Side Canal in HRCT images (n=30)		Left Side Canal in HRCT images (n=30)	
Types	Frequency	Percentage	Frequency	Percentage
I	21	70	23	76.7
IIA	5	16.6	5	16.7
IVA	4	13.4	2	6.6

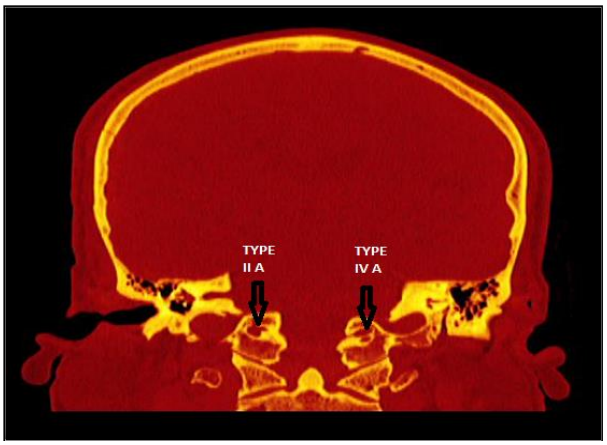

Figure 1: HRCT image of Brain showing Hypoglossal Canal of Type IIA - Left side & Type IVA - Right side

In Dry Skulls

On the right side, 70% of canals were simple (Type I). 8.57% of canals showed TYPE IIA pattern, 10% of canals showed type IIIA, 10% of canals showed type IVA and 1.43% showed type IVB bridging pattern. On the left side, 61.43% of canals were simple (Type I). 17.14% of canals showed TYPE IIA pattern, 5.71% of canals showed type IIIA, 12.86% of canals showed type IVA, 1.43% showed a type IVB pattern, and 1.43% of hypoglossal canals showed type V bridging pattern [Table 2].

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Table 2: Frequencies & Percentage of Bridging Trait Variations in Dry Skulls

Types	Right hypoglossal canal (n=70)		Left hypoglossal canal (n=70)	
	Frequency	Percentage	Frequency	Percentage
I	49	70.00	43	61.43
II A	06	8.57	11	15.7
IIB	07	10.00	01	1.4
IIIA	07	10.00	04	5.71
IVA	07	10.00	09	12.86
IVB	01	1.43	01	1.4
V	0	0	01	1.43

Figure 2: Hypoglossal Canal - Type IIa

Figure 3: Hypoglossal Canal - Type IIIA

Figure 4: Hypoglossal Canal - Type IVA

Figure 5: Hypoglossal Canal - Type IVB & IIA

DISCUSSION

The bridging and duplication pattern of the hypoglossal canal is a hyperostotic non-metric cranial variety that has attracted the interest of many early researchers. Wood Jones was the first to suggest that the varying incidences of these mutations may arise in various races and thus be valuable in anthropological investigations. His research also indicated that changes within a population could be unilateral or bilateral.[6]

The study of Singh et al. (2014) reported that 84% of skulls had no evidence of bridging. 4.32% of skulls had incomplete bridging, 7.68% had unilateral complete endocranial bridging, and 3.68% had bilateral complete endocranial bridging. No skulls were observed with complete exocranial and complete bridging along the whole extent of the canal.

In the present study, 65.71% of canals had no evidence of bridging. 20.72% of canals had incomplete bridging, and 11.43% had complete endocranial bridging. 1.43% of canals had complete exocranial bridging, and 0.71% had complete bridging along the whole extent of the canal.

According to Hauser et al. (1985), 4/5th of European skulls, 2/3rd of Egyptian skulls, and 3/4th of Peruvian skulls were observed with simple hypoglossal canals with no traces of bridging. Traces of division (type II & III) was observed in 26% of European skulls, 32% of Egyptian skulls, and 31% of Peruvian skulls.[4]

Ari et al. (2005) in Turkey population reported that 38% of canals were type I, 42% of canals were type II, 2% of canals were type III, 10% of canals were type IV, and 8% of canals were type V.[3]

Paraskevas et al. (2009) reported that in the Greek population, 59.49% of canals were type I, 18.10% of canals were type II, 0.86% of canals were type III, 19.83% of canals were type IV, and 1.72% of canals were type V.[8] In the present study, 65.71% of canals were type I, 12.86% were type II, 7.86% were type III, 12.86% were type IV, and 0.7% were type V .

Osunwoke et al. (2014), in the South Nigerian population, 4 out of 52 male skulls had bilateral double hypoglossal canals, and 3 out of 27 female skulls had bilateral double hypoglossal canals.[9]

According to Nikumbh et al. (2013), the unilateral double hypoglossal canal was noted in 25% of skulls, and a bilateral double hypoglossal canal in 3% of skulls.[10] Kanda et al. (2015) evaluated the

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prevalence of double hypoglossal canal in the Japanese population with multidetector computed tomographic scans. He reported that on the right side, 7.1% of canals were double hypoglossal canal and on the left side, 12.0% of canals were double hypoglossal canals. A bilateral double hypoglossal canal was observed in 2.2% of patients.[11]

In the present study, double hypoglossal canal was observed in 11.43% of the right canal and 15.71% of the left hypoglossal canal. A bilateral double hypoglossal canal was observed in 4.28% of skulls (3 skulls). The difference was because of regional and racial variations in the bridging pattern of the hypoglossal canal.

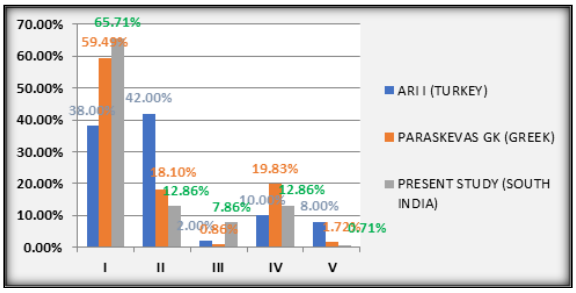

Figure 1: Comparison of bridging pattern of the hypoglossal canal in different population

Several Indian studies follow the dichotomous pattern of canal bridging exclusively. When the current study results were compared to past studies of different demographic groups, the incidence of the bridging pattern was higher in the current study than in the earlier studies of Nigeria (11.6%), Palestine (7%), Palestine contemporary (8.3%), and Burma (9.8%). Nonetheless, Egypt (16.6%), North America (24%), and South America (27.4%) populations have a low rate of duplication.[12,6] This variation in bridging pattern between population shows that environmental and genetic variables had a role in canal construction.[6]

CONCLUSION

Sound knowledge of bridging trait variations and morphometry of the hypoglossal canal can provide important benefits during surgical procedures such as trans condylar and supracondylar approaches. Important to anthropologists, forensic experts, radiologists & neurosurgeons.

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