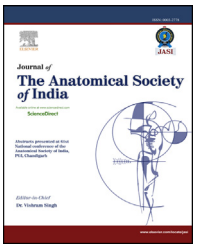
Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/jasi



Original Article

Bridging pattern of hypoglossal canal – Reclassified

Vishram Singh [a], *Ruchira Sethi* [b,*], *Poonam Kharb* [c], *Rashi Singh* [d]

[a] *Professor & Head, Department of Anatomy, Santosh Medical College, Ghaziabad, NCR Delhi, India*
[b] *Assistant Professor, Department of Anatomy, Santosh Medical College, Ghaziabad, NCR Delhi, India*
[c] *Professor, Department of Anatomy, SMS & R, Greater Noida Ghaziabad, India*
[d] *Senior Lecturer, Department of Paedodontics & Preventive Dentistry, Santosh Dental College, Ghaziabad NCR Delhi, India*

ARTICLE INFO

Article history:
Received 8 August 2014
Accepted 19 August 2014
Available online 20 September 2014

Keywords:
Cranial foramina
Canal
Hypoglossal canal
Bony bridging

ABSTRACT

Introduction: The hypoglossal canal is a constant feature of the human skull and presents variations in its morphology. These variations include duplication and bridging of the canal. There have been number of studies earlier which merely defined presence and absence of the bridging of the canal however none gave a detailed classification. Hence the aim of present study was to provide a detailed classification of the bridging pattern based on the observations on a large number of sample size.

Methods: The 625 skulls were procured from Department of Anatomy of GSVM Medical College, Kanpur, Santosh Medical College, Ghaziabad and School of Medical Sciences and Research, Greater Noida. The hypoglossal canal of each skull was examined and the bridging pattern was observed and classified. The skulls with no bridging were classified as Type 1; incomplete bridging was classified as Type 2; complete endocranial bridging as Type 3; exocranial bridging as Type 4 and complete bridging throughout the canal as Type 5. These categories were further subdivided according to unilateral or bilateral bridging of the canal.

Results: The results obtained show that the hypoglossal canal is the constant feature of occipital bone of the skull and invariably presents with morphological variations. Type 1 category was seen in 84% of skulls, Type 2 was observed in 4.32% with left side dominance. Type 3a category was seen in 7.68% and Type 3b in 4.16%. There was no skull with Type 4 and Type 5 category.

Discussion: The bridging pattern of hypoglossal canal is governed by molecular, environmental and racial factors. The detailed classification of bridging pattern is of great significance to the anthropologists, forensic experts, radiologists and neurosurgeons.

* *Corresponding author.*
E-mail address: ruchirasethi@gmail.com (R. Sethi).
http://dx.doi.org/10.1016/j.jasi.2014.08.005

1. Introduction

The study of morphological variations of cranial traits especially that of cranial foramina of human skull has been a field of considerable interest to researchers because of their anthropological and clinical significance.

The hypoglossal canal in the occipital bone is situated above the occipital condyles at the junction of its anterior one-third and posterior two thirds and is a constant feature of human skull.[1] It transmits (a) hypoglossal nerve which is the only motor supply to the muscles of tongue (b) ascending pharyngeal artery which supplies the cranial dura, (c) meningeal branch of hypoglossal nerve which provides sensory innervations to the duramater of the posterior cranial fossa and (d) the venous plexus which connects the inferior petrosal sinus, anterior condylar vein and paravertebral venous plexus.[2] The venous plexus is considered to be of great significance because it is the major source of venous drainage through the postsellar cranial cavity.[3,4]

Lesions involving the hypoglossal canal are rare and usually benign. They include hypoglossal nerve schwannomas, posterior fossa meningiomas, and jugulo-tympanic paragangliomas.[5] The decision to intervene surgically for these conditions is based not only on factors including tumour type, size, patient age, symptoms, etc but also on the detailed anatomical information of this foramen since the cranial foramina show considerable racial and regional variations. In the modern era of advanced technology and development where even skull surgeries are considered a mere brush of knife, small anatomical and anthropological detail available to surgeons can be of great clinical and surgical significance. Hence the aim of the present study is to identify the morphological variations of hypoglossal canal in a North Indian Population and propose a classification depending on the bridging pattern. In literature only one study done in Anatolian population attempts to describe the bridging of hypoglossal canal as per detailed method.[6] There has been no Indian study conforming to this pattern of classification for hypoglossal canal bridging. The present study is a descriptive analysis of hypoglossal canal bridging, describing not only the dichotomous pattern but also providing a detailed method of classification of bridging pattern of the canal.

2. Materials & methods

The present study was conducted on 625 dried skulls obtained from Department of Anatomy of GSVM Medical College Kanpur, Santosh Medical College Ghaziabad, School of Medical Sciences and Research Greater Noida. The skulls were observed for any damage to posterior cranial fossa and those in good condition were selected for further evaluation. In the present study a modified classification based on the dichotomous and detailed method of classification suggested by Berry and Berry[7] and Hauser & de Stefano[8] respectively is suggested. The hypoglossal canal bridging was observed and classified as per the below mentioned classification.

3. Results

The results obtained show Type 1 category in 84% of skulls i.e.527 skulls had no evidence of hypoglossal canal bridging whether incomplete in form of spines or spurs or complete. The incomplete bridging i.e Type 2 was seen in 4.32% (27 skulls) with preponderance of incompleteness on to the left side (2.72%) (Fig. 1). There was no skull with Type 2b variety. The Type 3a category (Fig. 2) which manifests as unilateral bifurcation of canal seen from the endocranial aspect was seen in total of 7.68% of skulls and in this category also the dominant side for bridging was left side of skulls (4.16%). Type 3b (Fig. 3) i.e. bilateral bridging was observed in 3.68%. There was no skull with exocranial bridging (Type 4) or complete bridging throughout the hypoglossal canal (Type 5).

4. Discussion

The bridging and duplication pattern of hypoglossal canal is one of the hyperostotic non-metric cranial variant which has been of clinical interest to many early researchers. Wood Jones was the first to propose that the differing incidences of these variants may occur in different races and hence might be useful in anthropological studies.[9] His study also suggested that the variations can be unilateral or bilateral within a specific population. Various factors have been suggested as potential cause for bridging in a given set of population, viz: (1) The hypoglossal canal develops by the fusion of occipital sclerotomes and the process of occipital chondrification at stage 17 while the development of the hypoglossal nerve occurs at stage 12. Embryologically, the nerve originates from several segments forming rootlets. These nerve rootlets enter into the hypoglossal foramen when they get enveloped in a fibrous sheath to form two or more nerve bundles explaining the division of canal into two or more compartments[10] (2) excessive ossification of connective tissues, during development[11] (3) Most of the skull bones are derived from neural crest mesenchyme and any defect in molecular regulation of these cells through HOX genes via fibroblastic growth factors (FGFs)may be the causative factor of duplication and multiplication of the canal,[12,13] thus taking into account all the three factors (vide supra) the detailed classification of the bridging pattern of the canal provides a potential insight in

Classification type	Description
Type 1	No evidence of bridging on both the sides
Type 2	Incomplete bridging (spines & osseous spurs)
a	Unilaterally
b	Bilaterally
Type 3	Complete endocranial bridging with duplication of canal
a	Unilaterally
b	Bilaterally
Type 4	Complete exocranial bridging
Type 5	Complete bridging of canal along whole extent

Fig. 1 – Incomplete bridging pattern (Type 2a).

Fig. 3 – Complete Bilateral bridging (Type 3b).

understanding the embryonic developmental process for hypoglossal canal and its bridging.

The present study revealed that bilateral single canal is the common feature of the human skulls in this population however incidence of bridging pattern was seen to an extent of 14.4% and the bilateral bridging pattern was 3.68%. The earlier work of Nikumbh et al[14] has shown a higher incidence of 28% but no reference regarding the regional origin of skulls was mentioned. The study of Zaidi et al[15] showed 12.5% incidence of duplication in population of UP origin, Out of which in 5% crania it was bilateral and in 7.5% cases it was unilateral. Other Indian studies also follow the dichotomous pattern of bridging of the canal only. On comparing the results of present work with early works; the incidence of bridging pattern was greater in the present study than the earlier studies of different population groups, viz: Nigeria (11.6%), Palestine (7%), Palestine modern (8.3%) and Burma (9.8%). However, a low incidence of duplication was observed from populations of Egypt (16.6%), North America (24%) and South America (27.4%).[15] This variation in bridging patterns in different population groups suggests role of environmental and genetic factors during formation of the canal.

Fig. 2 – Complete bridging pattern unilaterally (Type 3a).

Hypoglossal canal is also clinically important in some pathological conditions like occipital bone fracture, congenital defects, intra and extra cranial neoplasms. The bridging of the canal can cause compartmentalization of the canal causing compression on the structures passing through it. Though solitary compression of 12th cranial nerve is very rare and manifestation of symptoms (slurring of speech, atrophy of tongue etc) is difficult to define at an early stage, compression of the dominant venous plexus may produce sufficient symptoms to a patient. The venous plexus of the hypoglossal canal creates a link between the marginal sinuses and the superior jugular bulb and, indirectly, with the vertebral veins.[3,4,16] This venous plexus is a predominant constituent of the canal in man implying that it has a vital function in venous drainage in human species.[17]

5. Conclusion

The knowledge of variations of hypoglossal canal is of considerable importance to anthropologists, forensic experts, radiologists and neurosurgeons. It is of immense significance to anthropologists and forensic experts in better understanding the racial and regional variations; to radiologists in distinguishing normal from abnormal pattern on CT scan, MRI and to neurosurgeons in planning and execution of

microsurgical interventions at the base of skull in a safer way for better post-operative results. Since the present study is carried on a very large sample of skulls and the bridging pattern of hypoglossal canal is reclassified it will be of significant help to experts of different fields (vide supra).

Conflicts of interest

All authors have none to declare.

REFERENCES

1. De Gusta D, Gilbert WH, Turner SP. Hypoglossal canal size and hominid speech. *Proc Natl Acad Sci USA*. 1999;96(4):1800–1804.
2. Standring S. *Grays Anatomy: The Anatomical Basis of Clinical Practice*. 40th ed. London: Churchill Livingstone. Elsevier; 2009:584.
3. Lang J, Hornung G. The hypoglossal channel and its contents in the posterolateral access to the petroclival area. *Neurochorurgia*. 1993;36:75–80.
4. Reinhardt KR, Miller ME, Evans HE. The craniovertebral veins and sinuses of the dog. *Am J Anat*. 1992;111:67–87.
5. Hadley KS, Shelton C. Infratemporal fossa approach to the hypoglossal canal: practical landmarks for elusive anatomy. *Laryngoscope*. 2004;114:1648–1651.
6. Arı I, Kurt MA, Oygucu IH, et al. Variations in the bridging trait of the hypoglossal canal in 13th century Bizantine skulls. *Int J Osteoarchaeol*. 2005;15:140–145.
7. Berry AC, Berry RJ. Epigenetic variation in the human cranium. *J Anat*. 1967;101:361–379.
8. Hauser G, De Stefano GF. Variations in form of the hypoglossal canal. *Am J Phys Anthropol*. 1985;67:7–11.
9. Wood-Jones F. The non metrical morphological characteristics of the skull as criteria for racial diagnosis IV. *J Anat*. 1934;68:96–108.
10. O'Rahilly R, Muller F, Myer DB. The human vertebral column at the end of the embryonic period proper. The occipitocervical region. *J Anat*. 1983;136:181–195.
11. Richtsmeier JT, McGrath JW. Quantitative genetics of cranial non-metric traits in random bred mice: heritability and etiology. *Am J Phys Anthropol*. 1986;69:51–58.
12. Saddler TW. *Development of Head & Neck in Langman's Medical Embryology*. 11th ed. Philadelphia, USA: Wolter& Kluwer; 2009:265–291.
13. Sethi R, Singh V. Incidence of carotico clinoid canal in north Indian skulls with its clinical & medicolegal significance. *J Indo-Pacific Acad Forensic Odontol*. 2011;2(2):43–45.
14. Nikumbh RD, Nikumbh DB, Karambelkar RR, et al. Morphological study of hypoglossal canal and its anatomical variation. *Int J Health Sci Res*. 2013;3(6):54–58.
15. Zaidi SHH, Gupta Rakesh, Usman Nema. A study of hypoglossal canal in North Indian crania. *J Anat Soc India*. 2011;60(2):224–226.
16. Gisel A. Die Venen im Canalis nervi hypoglossi. *Zeitschr F Anat u Entwickl*. 1956;119:257–258.
17. Wysocki J, Kobryń H, Kobryńczuk F. Proportion analysis of hypoglossal canal elements in human, maca- cus and dog. *Med Sci Monit*. 1998;4(S2):52–54.