Original article

Morphological and morphometric study of the "vermian fossa" in Indian *human* adult skulls

Murlimanju, BV.[1]*, Prabhu, LV.[2], Sharmada, KL.[2], Saralaya, VV.[2], Pai, MM.[2], Kumar, CG.[2], Jiji, PJ.[2] and Dhananjaya, KVN.[3]

[1]MD, Assistant Professor, Department of Anatomy, Kasturba Medical College, Manipal University, 575004, Mangalore, Karnataka, India
[2]Department of Anatomy, Kasturba Medical College, Manipal University, 576104, Mangalore, Karnataka, India
[3]Department of Radiology, Kasturba Medical College – KMC, Manipal University, 576104, Mangalore, Karnataka, India
*E-mail: flutemist@gmail.com

Abstract

Introduction: The objective was to find incidence of "vermian fossa" of skull in Indian population and to study its morphology and morphometry. **Materials and Methods:** The present study included 35 specimens which comprised 20 cranial bases and 15 occipital bones. The inner aspects of posterior cranial fossa were examined to find the presence of the vermian fossa. The fossae were macroscopically classified as triangular (type 1) and quadrangular shapes (type 2) and atypical, i.e., than triangular or quadrangular (type 3). The length and width of the fossa were determined by using digital vernier caliper. **Results:** It was observed that the fossa was present in 25 specimens (71.4%). Its shape was triangular in 19 skulls (76%), quadrangular in 2 (8%) and atypical (type 3) in 4 (16%). The mean length and width of the fossa (± SD) were "13.6 ± 4.4 mm" and "11.9 ± 3.3 mm" respectively. **Conclusion:** The triangular morphology was observed in the overwhelming majority of the vermian fossae. We believe that the details about this bony landmark are of importance for neurosurgery and are also enlightening for neuroanatomy and neuroradiology.

Keywords: cranium, morphology, morphometry, occipital, shape, vermian fossa.

1 Introduction

"The vermian fossa" (VF) is a small depression at the lower part of the internal occipital crest, over which the inferior part of the vermis of the cerebellum lies (PODDAR and BHAGAT, 2007). It was reported that the VF is of varying size and is found occasionally on the dorsal aspect of the foramen magnum. The VF is also called middle cerebellar fossa of Verga (BERGMAN, THOMPSON, AFIFI et al., 1988). It is bounded by the lips of the internal occipital crest which diverge around the foramen magnum giving the fossa a somewhat triangular shape. The fossa might be partitioned into an upper and a lower part by a bone ridge (BERGMAN, THOMPSON, AFIFI et al., 1988). Kale, Öztürk, Aksu et al. (2008) conducted a detailed evaluation of this landmark in Turkish skulls and observed its presence in 8.22% cases. Berge and Bergman (2001) reported the frequency of VF as 4% and Kale, Öztürk, Aksu et al. (2008) had reported a frequency of 11.4% on the basis of findings by other authors. Details of VF are not available in the literature. The present study aimed to determine the incidence of VF in Indian population and to study its shape and morphometrical details.

2 Materials and Methods

The study was made on 35 specimens which comprised 20 cranial bases (with vault removed) and 15 occipital bones, which were obtained from the human neuroanatomy laboratory of our institution. The "inner aspects of the posterior cranial fossa" was examined for the presence of the VF. Skulls and occipital bones which showed pathological changes or were damaged were excluded from the study. The fossae were macroscopically classified as triangular (type 1), quadrangular (type 2) and atypical (type 3). The last class comprised the fossae which were other than triangular or quadrangular. The length and width of the VF were determined with a digital vernier caliper. The length was measured from the most superior to the most inferior part of the fossa. The width was measured at its maximum. The data are represented as mean ± SD.

3 Results

The VF was observed in 25 specimens and was found absent (Figure 1F) in the remaining 10 skulls. The VF was triangular (type 1, Figure 1A) in 19 specimens (76%) and quadrangular (type 2, Figure 1B) in 2 (8%). In 4 (16%) specimens it had unusual morphology and was considered as atypical (type 3). The incidence of the VF in Indian skulls was therefore estimated as 71.4%. The mean length and width of the fossa were 13.6 ± 4.4 mm and 11.9 ± 3.3 mm respectively. Among atypical fossae, one was deepened at its lower part (Figure 1C), one was partitioned (Figure 1D) and two were widened (Figure 1E).

4 Discussion

The inner surface of squamous occipital bone is divided into four deep compartments by an irregular, median, internal occipital protuberance and from ridged sagittal and horizontal extensions from that protuberance. The two superior fossae are shaped to accommodate the occipital

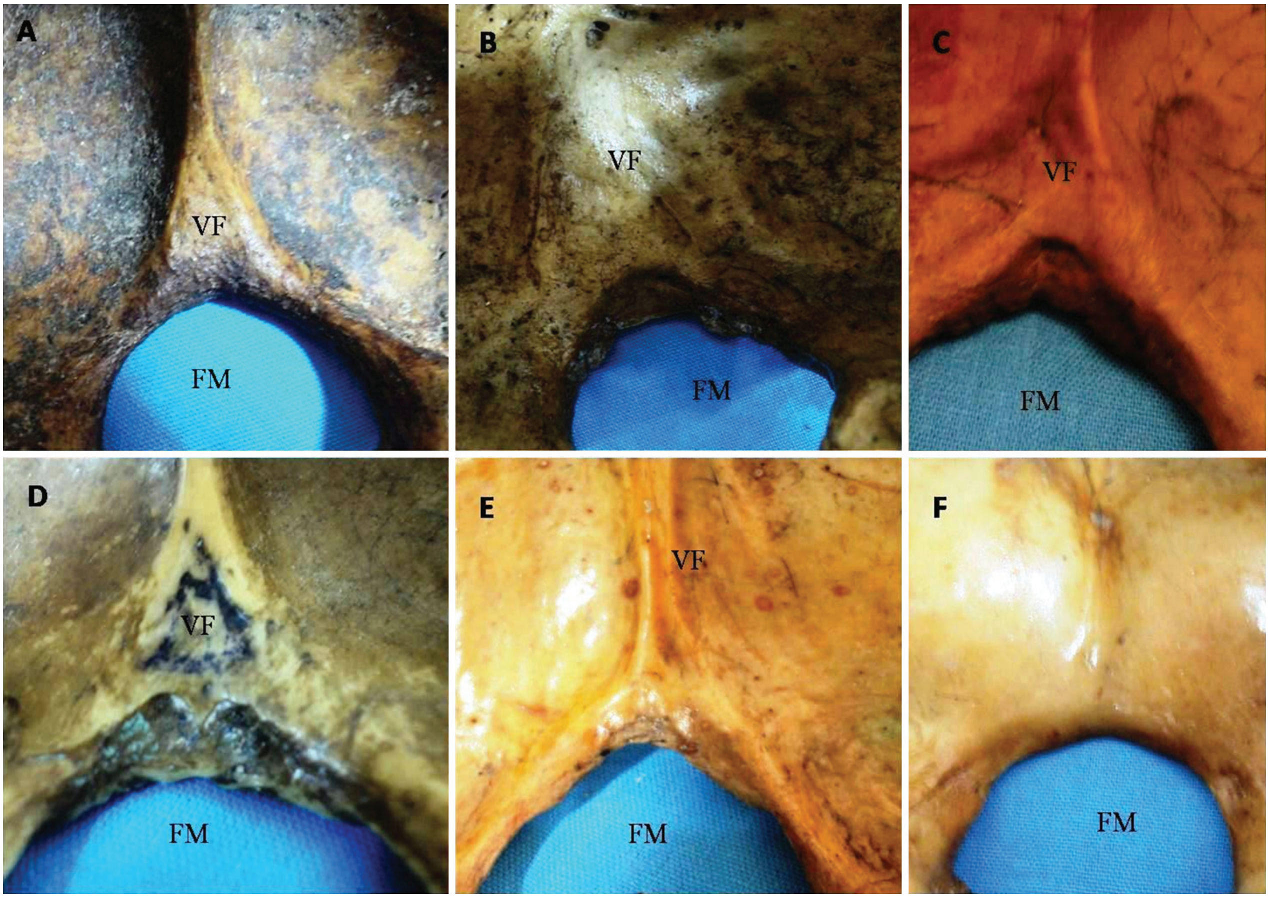

Figure 1. Morphological types of vermian fossa (source of classification – Kale, Öztürk, Aksu et al. (2008)). A: triangular shape (type 1); B: quadrangular shape (type 2); C: atypical, deep (type 3); D: atypical, partitioned (type 3); E: atypical, widened (type 3); F: absent vermian fossa. (VF = vermian fossa; FM = foramen magnum).

poles of the cerebral hemispheres, the inferior fossae to accommodate the cerebellar hemispheres. A prominent internal occipital crest descends from the protuberance and bifurcates near the foramen magnum, providing an attachment for the falx cerebelli (STANDRING, 2005). Lang (1991) described the VF as a V-shaped space generated in some cases by a division of the falx cerebella at its inferior end. This fossa lodges the inferior part of the cerebellar vermis, which include tuber, pyramis, uvula and nodule (STANDRING, 2005). Although Black (1916) believed that the vermis is not normally in contact with the occipital bone, most authors have stated that this fossa lodges the inferior part of the vermis. East (1926) reported, a fairly well marked VF in animals like lemur and marmoset, while it was found absent in the macacus monkey and cercopithecus. Kale, Öztürk, Aksu et al. (2008) identified 13 VF, 10 out of 129 occipital bones and 3 out of 29 basicrania, among 158 Turkish skulls and hence reported the incidence as 8.2%. For the first time in the literature, they classified the fossa into two types, type 1 (triangular), type 2 (quadrangular), and termed the shapes other than these as atypical. In their study, type 1 and type 2 were observed in 7 and 4 cases respectively. The remaining two were considered atypical, the first one looked like a triangle and was especially deep, and the other had lateral borders getting far away from each other. In the present study, the incidence of the VF was higher than in previous reports. We believe that this difference might depend on racial variations; the relatively small study sample may have also played a role. Therefore this pilot study is worth to being followed by one on a larger sample. In the present study, the triangular shape was observed in 19 specimens, the quadrangular in 2 cases. The remaining 4 specimens were considered as atypical. Therefore, the triangular shape seems to be more frequent in Indian than in Turkish people. A comparison between the present results on Indian skulls and those of Kale, Öztürk, Aksu et al. (2008) on Turkish skulls is presented in Table 1.

Kale, Öztürk, Aksu et al. (2008) reported that a few authors have named the VF, when quadrangular shaped as fossa occipitalis mediana. In their opinion, the only difference between a VF and a true fossa occipitalis mediana is the depth of the fossa and they proposed that the depth of the VF can provide a clue about the shape of inferior part of the cerebellar vermis. In the present study, the mean length and width of the fossa were “13.6 ± 4.4 mm” and “11.9 ± 3.3 mm” respectively. This is different from the findings of Kale, Öztürk, Aksu et al. (2008), since in the latter study the average height and width of the VF were 27.8 mm and 18.4 mm respectively. We cannot exclude that this difference might be influenced by the small sample size of the present study. Nonetheless, we believe that data like these ones may be of value in studies on diseases that cause

Table 1. Comparison of morphological and morphometric findings on vermian fossa between Indian and Turkish skulls.

	Kale, Öztürk, Aksu et al. (2008)	**Present study (2010)**
Vermian Fossa	Turkish	Indian
incidence	8.2%	71.4%
type 1 (triangular)	53.8%	76%
type 2 (quadrangular)	30.8%	8%
type 3 (atypical)	15.4%	16%
average length	27.8 mm	13.6 mm
average width	18.4 mm	11.9 mm

alterations in the size and morphology of VF. Some studies have stressed the necessity for quantitative, morphometric analyses in the diseases of the posterior cranial fossa (HASHIMOTO, TAYAMA, MIYAZAKI et al., 1993), also taking advantage of techniques as computerized tomography and nuclear magnetic resonance.

The anatomy of cerebellum and especially of the vermis is of interest to many clinicians. It has been reported that some cases of cerebellar cortical dysplasia are associated with vermian malformations (SOTO-ARES, DELMAIRE, DERIES et al., 2000); vermian dysgenesis is considered as a malformative disorder (BODDAERT, DESGUERRE, BAHI-BUISSON et al., 2010). According to Soto-Ares, Devisme, Jorriot et al. (2002), magnetic resonance imaging revealed global vermian hypoplasia associated with marked cortical dysplasia in one case of dysgenesis. Robinson, Blaser, Toi et al. (2007) described a few criteria to evaluate the vermian growth, including vermian biometry and the relationship between the superior and inferior lobes in the fetuses. Siebert (2006) proposed basic morphologic definitions of posterior fossa anomalies, in the hope that better agreement can be reached between clinical and pathologic diagnoses. In neurosurgery, the combined transventricular and supracerebellar infratentorial approach are practiced to remove midline tumours of the posterior fossa. This approach will avoid unnecessary splitting of the cerebellar vermis (HERMANN, RITTIERODT and KRAUSS, 2008). Due to these reasons of clinical interest, we believe that the VF, which accommodates the inferior part of the vermis, needs to be studied anatomically. The operating surgeon may thus have an anatomical reference along with a detailed morphological description of neighbour structures.

Medical progress needs a more accurate knowledge of the variability of human morphology to improve the diagnosis and therapeutic performance (SANUDO, VAZQUEZ and PUERTA, 2003). The clinician who operates intracranially or interprets radiological imaging should be aware of the anatomical variations which may be found in the posterior cranial fossa (SHOJA, TUBBS, KHAKI et al., 2006). The present study might also help those who are involved with pathologies around the foramen magnum, like Arnold Chiari malformation. Future implications of this study include correlation of the data with surgically relevant considerations, for example, the relationship between the size and shape of the VF and the anatomy of the occipital sinus. The present study could be correlated by radiologic and surgical data.

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