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Original Research Article

A Cross-Sectional Study on the Morphology of the External Occipital Protuberance in Dry Skull

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Abstract:

Background: The external occipital protuberance (EOP) is a midline bony prominence located on the posterior surface of the occipital bone and serves as an important anatomical landmark in clinical, radiological, and forensic practice.

Methods: The present cross-sectional study was conducted to evaluate the morphological variations of the external occipital protuberance in 38 adult dry human skulls obtained from the osteology collection of the Department of Anatomy at NMCH Patna. Each skull was examined for the presence, shape, and degree of prominence of the EOP. The protuberance was classified based on gross morphological appearance into smooth/flat, crest-shaped, spine-like, and markedly prominent types. The frequency and percentage distribution of each morphological type were recorded and analyzed. Among the 38 skulls examined, the EOP was present in all specimens with varying degrees of prominence. The most common morphological type observed was the crest-shaped variety, followed by smooth/flat and spine-like forms. Markedly prominent EOP was observed in a smaller proportion of skulls. Considerable variation in size and projection was noted among the specimens.

The observed morphological diversity may be attributed to genetic factors, mechanical stress from muscle attachments such as the trapezius and ligamentum nuchae, and developmental influences. Knowledge of these variations is clinically significant for neurosurgical approaches, radiological interpretation, anthropological assessment, and forensic identification. The findings of this study add to the existing anatomical literature and may serve as a reference for future morphometric and clinical research.

Conclusion: The present cross-sectional study on 38 adult dry human skulls demonstrated that the external occipital protuberance (EOP) exhibits considerable morphological variation in terms of shape and degree of prominence. Although the EOP was present in all specimens, its presentation ranged from smooth or flat forms to crest-shaped, spine-like, and markedly prominent types. The crest-shaped variety was the most commonly observed pattern in the present study. A thorough understanding of these morphological variations is clinically significant for neurosurgeons, radiologists, and orthopedic surgeons during posterior cranial and cervical procedures. Furthermore, the observed differences may have value in anthropological and forensic investigations, particularly in skeletal identification.

Keywords: External occipital protuberance; Occipital bone; Dry skull; Morphology; Cranial variations; Cross-sectional study; Anatomical landmark; Osteology; Forensic anthropology; Morphometric analysis.

Introduction

The external occipital protuberance (EOP) is a midline bony prominence located on the posterior surface of the occipital bone, at the level of the external occipital crest. It serves as an important anatomical landmark for the attachment of the ligamentum nuchae and the trapezius muscle. Due to its palpable nature and consistent location, the EOP plays a significant role in clinical examination, neurosurgical procedures, radiological interpretation, and anthropological assessments. Morphological variations of the EOP have been documented in different populations. These variations may range from a smooth or flat surface to crest-shaped, spine-like, or markedly prominent projections. The degree of prominence may be influenced by genetic factors, mechanical stress from muscle attachments, age, sex, and developmental changes. In recent years, increased attention has been given to prominent EOP due to its clinical association with occipital pain, external occipital neuralgia, and its importance as a reference point in cranial measurements.

From an anthropological and forensic perspective, the morphology of the EOP contributes to sex estimation and population studies, as prominent protuberances are often reported more frequently in males. Additionally, accurate knowledge of its variations is essential during posterior cranial surgical approaches to avoid procedural complications. Despite its anatomical and clinical relevance, limited data are available regarding the morphological variations of the external occipital protuberance in dry skull specimens. Therefore, the present cross-sectional study was undertaken to examine and document the morphological characteristics of the external occipital protuberance in 38 adult dry human skulls, aiming to contribute to the existing body of anatomical knowledge and provide baseline data for clinical and forensic applications.

Materials and Methods

The present cross-sectional descriptive study was conducted in the Department of Anatomy at Nalanda Medical College and Hospital Patna, Bihar. using 38 adult dry human skulls obtained from the institutional osteology collection. Study duration is one years. The skulls included in the study were intact and free from visible deformities, fractures, or pathological changes affecting the occipital region. Skulls with damaged or eroded occipital bones were excluded from the study. The age and sex of the specimens were unknown.

Each skull was examined in the anatomical position, and the external occipital protuberance (EOP) was observed on the posterior surface of the occipital bone along the midline. The EOP was assessed for its presence, shape, and degree of prominence through gross visual inspection and palpation.

Based on morphological appearance, the EOP was classified into the following types:

1. Smooth/Flat type – minimal or no visible projection.
2. Crest-shaped type – elongated ridge-like projection.
3. Spine-like type – pointed bony projection.
4. Markedly prominent type – well-developed and conspicuously projecting protuberance.

The frequency of each morphological type was recorded and expressed as percentages. Observations were tabulated and analyzed using descriptive statistical methods.

Ethical clearance was obtained from the Institutional Ethics Committee prior to the commencement of the study, as per institutional guidelines.

Results

A total of 38 adult dry human skulls were examined for the morphology of the external occipital protuberance (EOP). The EOP was present in all 38 specimens (100%) with varying degrees of prominence and morphological patterns.

Based on gross morphological assessment, the EOP was classified into four types. The crest-shaped type was the most frequently observed variant, seen in 14 skulls (36.8%). The smooth/flat type was observed in 10 skulls (26.3%). The spine-like type was identified in 8 skulls (21.1%). The markedly prominent type was observed in 6 skulls (15.8%). Considerable variation in the size and projection of the EOP was noted among the specimens. The markedly prominent type demonstrated a well-defined bony projection at the midline of the occipital bone, while the smooth/flat type showed minimal projection. No accessory ossicles or abnormal growths were observed in the study sample.

Table 1: Distribution of morphological types of External Occipital Protuberance (n = 38)

Morphological Type	Number of Skulls	Percentage (%)
Smooth/Flat	10	26.3%
Crest-shaped	14	36.8%
Spine-like	8	21.1%
Markedly Prominent	6	15.8%
Total	38	100%

These findings demonstrate noticeable morphological diversity of the external occipital protuberance among the studied skulls.

Discussion

The external occipital protuberance (EOP) is an important midline bony landmark on the occipital bone with significant anatomical, clinical, and anthropological relevance. The present cross-sectional study analyzed the morphological variations of the EOP in 38 adult dry human skulls and demonstrated noticeable diversity in its shape and prominence.

In the present study, the EOP was observed in all specimens (100%), although the degree of projection varied considerably. The crest-shaped type was the most common variant, followed by the smooth/flat and spine-like types, while the markedly prominent type was least common. These findings are consistent with previous anatomical observations that report variability in the morphology of the EOP among different populations. The presence of a well-developed or

markedly prominent EOP may be attributed to mechanical stress exerted by the attachment of the trapezius muscle and ligamentum nuchae, leading to increased bone remodeling at the site of insertion.

Morphological variations of the EOP have gained increasing clinical attention in recent years. A markedly prominent EOP has been associated with occipital pain and external occipital neuralgia in some individuals. From a surgical perspective, the EOP serves as a crucial landmark in posterior cranial and cervical procedures. Accurate knowledge of its variations helps neurosurgeons and orthopedic surgeons avoid complications during operative approaches to the posterior cranial fossa. From an anthropological and forensic standpoint, the degree of prominence of the EOP is often considered in sex estimation, as more pronounced protuberances are generally reported in males due to stronger muscle attachments. Although the sex of the skulls in the present study was unknown, the observed morphological diversity highlights the need for population-based data to improve reliability in forensic identification.

The limitations of the present study include a relatively small sample size (n = 38) and the absence of sex and age determination of the specimens, which restricts comparative analysis. Future studies with larger sample sizes and morphometric measurements would provide more comprehensive data and allow correlation with sex, age, and population differences.

Overall, the findings of this study contribute to the existing anatomical literature by documenting the morphological variations of the external occipital protuberance and emphasizing its clinical and forensic significance.

Conclusion

The present cross-sectional study on 38 adult dry human skulls demonstrated that the external occipital protuberance (EOP) exhibits considerable morphological variation in terms of shape and degree of prominence. Although the EOP was present in all specimens, its presentation ranged from smooth or flat forms to crest-shaped, spine-like, and markedly prominent types. The crest-shaped variety was the most commonly observed pattern in the present study. These variations may be attributed to genetic factors, developmental influences, and mechanical stress at the site of muscle and ligament attachments. The findings highlight the anatomical diversity of the EOP and reinforce its importance as a reliable anatomical landmark. A thorough understanding of these morphological variations is clinically significant for neurosurgeons, radiologists, and orthopedic surgeons during posterior cranial and cervical procedures. Furthermore, the observed differences may have value in anthropological and forensic investigations, particularly in skeletal identification. studies incorporating larger sample sizes, sex determination, and detailed morphometric analysis are recommended to enhance the applicability and generalizability of the findings.

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