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Original Research Article

LOCKED AT THE JUNCTION: MORPHOLOGICAL INSIGHTS INTO OCCIPITALISATION OF THE ATLAS IN A NORTH INDIAN POPULATION

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ABSTRACT

Background: Occipitalisation of the atlas is a congenital craniovertebral anomaly characterized by partial or complete fusion of the atlas vertebra with the occipital bone. It is an important anatomical variant that may have significant clinical consequences [1]. This anomaly can interfere with normal neck movements, contribute to neurological symptoms, and complicate surgical or radiological evaluations. This study aims to assess the incidence, morphological patterns, and clinical relevance of occipitalisation of the atlas vertebra in adult human skulls examined in the Department of Anatomy during teaching sessions with MBBS students.

Materials and Methods: Thirty adult dry human skulls were studied at Government Medical College, Amritsar. The skulls were visually examined and measured for anatomical features suggestive of occipitalisation. Observations were documented photographically and morphometrically.

Results: Two out of thirty skulls exhibited features of occipitalisation, indicating a prevalence of 6.67%. Of these, one skull showed complete fusion of the atlas with the occiput, and the other demonstrated partial fusion with a visible foramen between the fused bones.

Conclusion: Occipitalisation of the atlas, though infrequent, has important clinical, radiological, and surgical implications [4,10,13]. Anatomical knowledge of this condition is essential for accurate diagnosis and effective management. This study underscores the value of recognizing such anomalies in anatomical education and clinical practice.

Keywords: Occipitalisation, Atlas vertebra, Craniovertebral anomalies, Congenital fusion.

INTRODUCTION

The craniovertebral junction (CVJ) is a functionally significant anatomical region that provides structural stability while allowing mobility between the skull and cervical spine. The CVJ includes the occipital bone, atlas (C1), and axis (C2), and is critical for head rotation and flexion.[1,2] Congenital fusion of the atlas to the occipital bone, referred to as occipitalisation or atlanto-occipital assimilation, is a rare but significant anomaly.

Embryologically, this condition arises due to failure of segmentation between the fourth occipital somite and the first cervical sclerotome.[3] It can occur in isolation or be associated with syndromes such as Klippel-Feil syndrome or basilar invagination. Prevalence varies between populations: 0.14% to 3% in clinical settings, and up to 10% in osteological series.[4-10]

Occipitalisation may be asymptomatic or present with headaches, limited neck motion, or vertebrobasilar insufficiency.[11] It has implications in radiology, surgery, and anesthesia. This study was undertaken to observe its incidence and morphological variations in a North Indian population to enrich anatomical understanding and improve clinical outcomes.

MATERIALS AND METHODS

This descriptive osteological study was conducted in the Department of Anatomy, GMC Amritsar. Thirty dry adult skulls of unknown sex and age were examined. Skulls showing postmortem damage or destruction of the CVJ were excluded.

Each skull was assessed manually for evidence of occipitalisation. Morphometric data, including the width and height of the foramen magnum and distances between occipital condyles, were recorded using a digital vernier caliper. Fusion was classified as complete or partial, and unilateral or bilateral.

Photographs were taken for documentation, and two faculty members independently confirmed the findings. Ethical approval was deemed exempt as this study used archival teaching material and did not involve human participants.[8]

Observations

Occipitalisation was found in 2 of 30 skulls (6.67%).

Skull 12: Complete fusion on the right side between the atlas and occipital bone with no visible foramen. Posterior arch of atlas fused with occipital bone. The groove for vertebral artery was absent.

Skull 26: Partial fusion on Left side. Complete fusion on the Right side. A narrow foramen (approx. 4.6 mm) was present between atlas and occiput. Groove for vertebral artery was shallow on the opposite side. [Figure 1]

No bilateral cases were found. Both cases were unilateral and involved the posterior arch only.

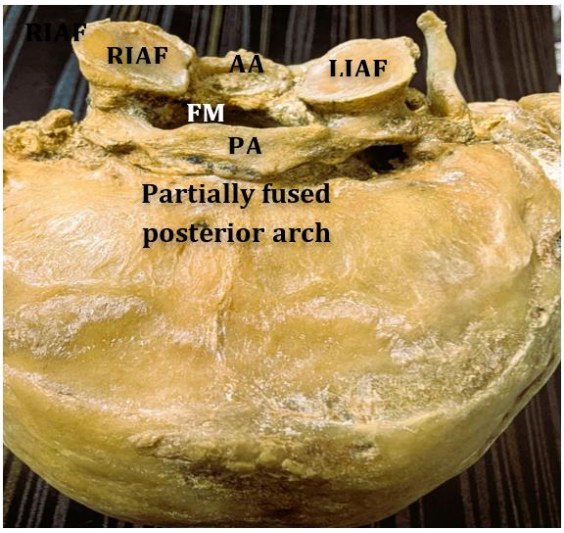

Figure 1: AA- Anterior arch, PA- Posterior arch, LIAF- Left inferior articular facet, RIAF- Right inferior articular facet, FM- Foramen magnum.

RESULTS

The incidence of occipitalisation was 6.67%, consistent with previous osteological studies in the Indian subcontinent.[6,7] One case demonstrated complete bony union, and the other showed partial union with a persistent foramen. In both cases, the fusion was unilateral and involved the posterior arch. No significant anomalies were noted in the rest of the skulls. The altered morphology of the foramen magnum in affected skulls did not indicate narrowing severe enough to suggest compression, but anatomical deviations were clearly visible.

DISCUSSION

Occipitalisation, as a congenital malformation, reflects a developmental failure in the segmentation of the craniovertebral axis.[2,3] Its prevalence varies globally and may be underreported in clinical literature. The observed rate of 6.67% in our study aligns with regional findings reported by Mishra and Panigrahi,[7] and Shrestha and Dhungel.[8]

Radiologically, occipitalisation can be mistaken for C1 fractures. It is often misinterpreted unless accompanied by clinical symptoms. CT and MRI play a crucial role in diagnosis.[9-12] Clinicians must distinguish true congenital fusion from traumatic nonunion or degenerative changes.

Clinically, it may present symptoms ranging from headaches to neurological deficits, depending on the extent of fusion and involvement of neurovascular structures.[10,11] Surgeons must take special care during cervical spine surgeries to avoid iatrogenic injury.

Our findings emphasize the need to document such variations in anatomical teaching, radiological evaluation, and preoperative planning.[13-15]

CONCLUSION

Occipitalisation of the atlas is an uncommon but significant anomaly. It was found in 6.67% of the skulls studied. Unilateral involvement and posterior arch fusion were predominant. These findings corroborate the importance of anatomical variation awareness in both academic and clinical domains. Further studies with larger samples and radiological correlation are recommended.[4,9,13]

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