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Case Report

Anatomical and clinical correlates of the precondylar tubercle

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Abstract

The possible presence of the precondylar tubercle should be considered in order to avoid misinterpretation in radiographic images or confusion during surgical intervention. This study examines dry skulls in order to describe and report the frequency of the precondylar tubercle and similar variations at the anterior margin of foramen magnum. Axial CT was used to demonstrate the appearance of bilaterally prominent precondylar tubercles in one skull. Precondylar tubercles were observed in 10% of the skulls. Other simulating observations included the presence of a midline spur, bilateral depression anteromedial to the occipital condyles, third occipital condyle, and a partly divided occipital condyle. Most of these variations were associated with septation of the hypoglossal canal. The presence of a mere precondylar tubercle is not expected to produce neurological manifestations, but its possible association with other variations should be considered.

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Key words [craniovertebral junction] [anatomical variations] [foramen magnum] [precondylar tubercle] [hypoglossal canal]

Introduction

The precondylar tubercle is a small occasional tubercle located immediately anterior to the occipital condyle. When present, it replaces the small depression that usually provides attachment for rectus capitis anterior muscle [1].

The precondylar tubercle has been described in anthropology literature as one of the non-metrical human cranial traits for the estimation of race from skeletal data. Non-metric traits are skeletal manifestations such as additional sutures, facets, bony processes, canals and foramina, which occur in a minority of skeletons and were thought to suggest familial affiliations. Some non-metric traits are believed to be occupational stress markers, rather than phenotypic. This is because human bone is plastic and responds to muscle development by functional pressures [2].

Developmental events at the craniovertebral junction can help in our understanding of the etiology of related variations [3]. The precise anatomy at the anterior margin of foramen magnum is of considerable importance to neurosurgeons [4]. Some variations which decrease the potential space for the lower brain stem and cervical cord can result in neurological symptoms [5].

Case Report

Fifty dry adult skulls were examined for variations at the anterior margin of foramen magnum. One skull with bilaterally prominent precondylar tubercles was scanned by using a spiral computerized tomography (CT) scan to demonstrate the radiographic appearance.

The precondylar tubercle was observed in 5 skulls (10%). One was with a centrally placed precondylar tubercle (Figure 1a) and one with a well-developed unilateral tubercle (Figure 1b). In the remaining three skulls, the precondylar tubercles were bilateral. Of the latter, one was well-developed and associated on both sides with a depression in the region between the tubercle and the occipital condyle (Figure 1c). Figure 2 shows the appearance of the bilateral precondylar tubercles illustrated in Figure 1c in axial CT.

Other observations that mimic a precondylar tubercle included one skull with a midline spur at the anterior margin of foramen magnum. Another skull showed a bilateral depression anteromedial to the occipital condyles similar to that shown in Figure 1c but without a precondylar tubercle; the depression was associated with thickening of the anterior margin of foramen magnum (Figure 3a). Finally, a third occipital condyle was observed in two skulls (4%). One third occipital condyle was well-developed and associated with the presence of a transverse ridge on the articular surface of the “proper” occipital condyles, partially dividing the “proper” condyle into two parts (Figure 3b). The less-developed third occipital condyle was on the other hand associated with a well-developed median spur (Figure 3c).

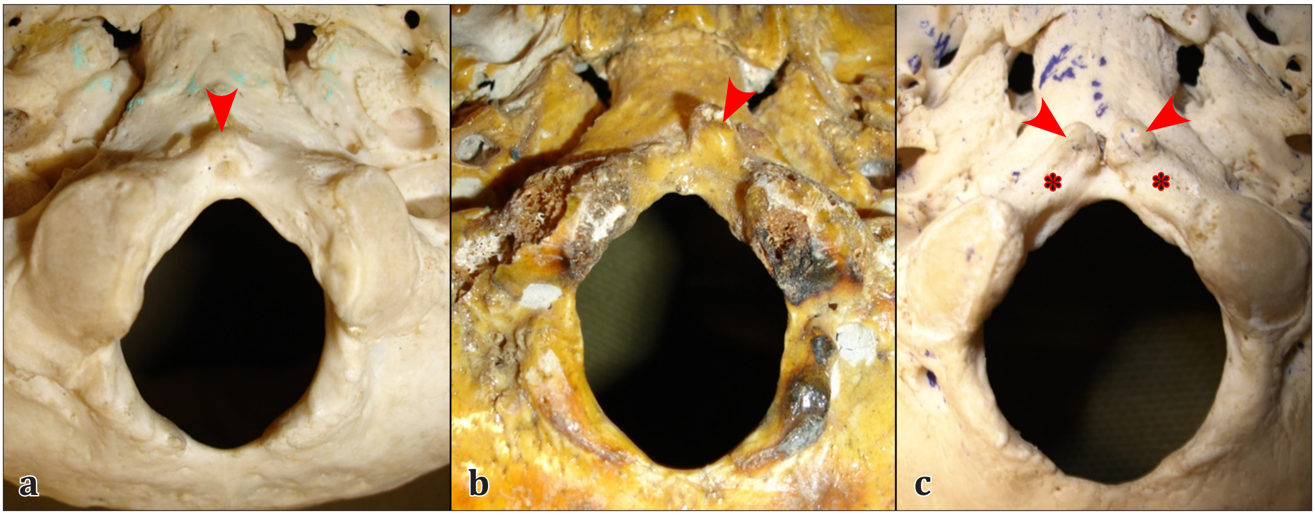

Figure 1. Types of *precondylar tubercle* ***(arrowheads)***. **a)** central, **b)** unilateral, **c)** bilateral precondylar tubercles with a *depression* ***(asterisk)*** in the region between each tubercle and the occipital condyle.

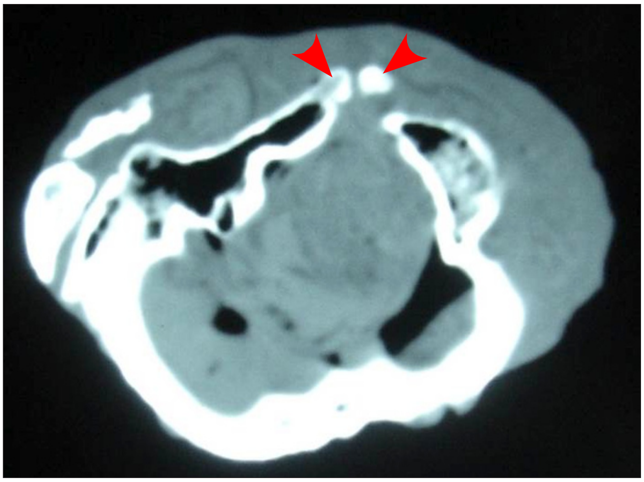

Figure 2. Axial CT slice at the base of a dried skull (same as in Figure 1c) with well-developed bilateral *precondylar tubercles* ***(arrowheads)***. Note the shadow of the encapsulating paraffin wax that was used to minimize the bone/air artifact.

In eight of the above nine cases, the bony variation at the anterior margin of foramen magnum was associated with a unilateral or bilateral variation of the hypoglossal canal including a complete or incomplete septum and multiple canals. The skull with unilateral precondylar tubercle was the only one that did not show variation in the hypoglossal canal. A bipartite hypoglossal canal (unilateral or bilateral) was also observed in four other skulls without accompanying variation around foramen magnum.

Discussion

The 10% incidence of precondylar tubercle reported here fits well with other studies which reported incidence rates up to 20% [6, 7]. The 4% incidence of the third occipital condyle in this study is reported by others to range from 0.5% to 3% [1, 7]. In this study, the third occipital condyle was not solitary but associated with two of the following variations: midline spur, septation of the hypoglossal canal and a transverse ridge on the articular surface of the "proper" occipital condyles. A case of a third occipital condyle has also been reported to be associated with duplication of both occipital condyles and a bony septation of both hypoglossal canals [8].

A partly divided occipital condyle is also described by Bergman et al. [1]. Its incidence has been reported to be 0.8% [9]. In this study, it was observed in one skull where it was associated with a third occipital condyle and a bipartite hypoglossal canal.

The spur at the anterior margin of foramen magnum has been attributed to ossification of the ligament of the odontoid process [1]. However, its association with a septate hypoglossal canal in the two cases observed in this study together with a third occipital condyle in one of them should attract attention to an embryological factor behind its formation.

The presence of a bipartite hypoglossal canal may be understood when the posterior part of the skull that develops around the notochord is considered to be basically comparable to one or more vertebrae. Thus the occipital bone is formed by the fusion of the sclerotomes corresponding to the roots of the hypoglossal nerve [10].

Variations at the craniovertebral junction are expected to associate one another from the embryological point of view [3, 10]. Such association has been reported [8] and was observed in this study particularly in the septation of the hypoglossal canal which was associated in 75% of the cases with a variation at the anterior margin of foramen magnum.

Anatomically speaking, the location of a mere precondylar tubercle is not expected to produce neurological manifestations

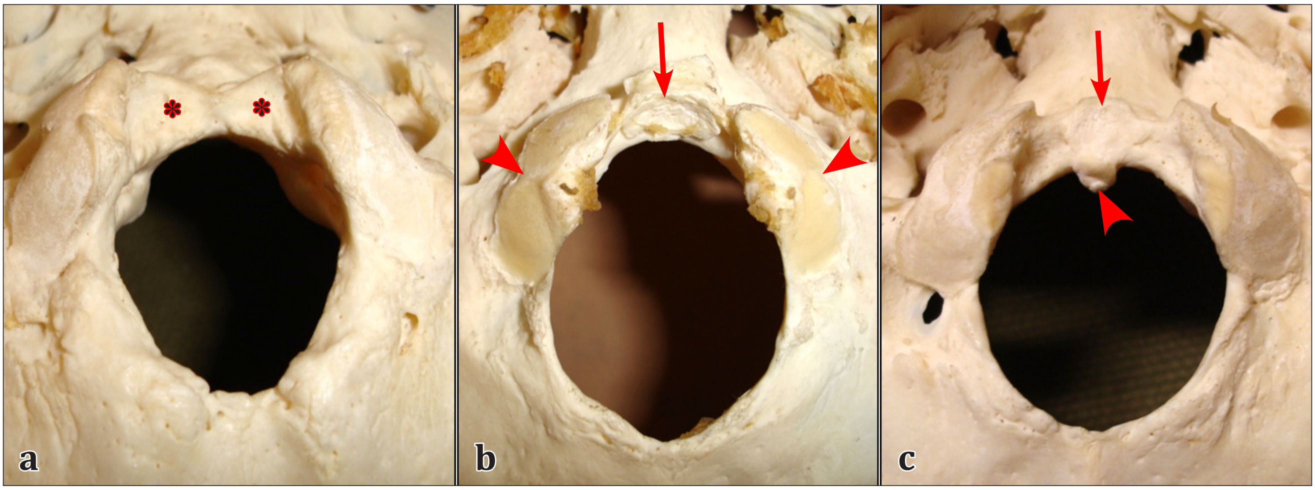

Figure 3. Variations at the anterior margin of foramen magnum. **a)** Bilateral *depression (**asterisk**)* anteromedial to the occipital condyles. **b)** *Third occipital condyle (**arrow**)* associated with a transverse ridge at the articular surface of the *occipital condyles (**arrowheads**).* **c)** *Third occipital condyle (**arrow**)* associated with a *median spur (**arrowhead**).*

resulting from compression since it is located outside the circumference of foramen magnum. However, its association with other variations dictated by the embryological events should be considered as clinically significant.

The small size and location of the precondylar tubercles might evade plain radiographic films. The CT image put forward in this study should increase the awareness of their shape and location and attract the attention to their presence for differential diagnosis. Recognition of these structures and associated variations help in distinguishing variants from unusual structures during CT examinations, and in avoiding confusion during surgical intervention.

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