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Short Report

Precondylar tubercles on the basiocciput of adult human skulls

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ABSTRACT

The basiocciput of 265 Indian adult human skulls was examined for precondylar tubercles, which are single or paired osseous formations anterior to the occipital condyles and foramen magnum. Of the 14% of skulls displaying these tubercles unilaterally or bilaterally, 5.3% demonstrated ridges, 4.9% showed spines and 3.8% exhibited processes. Sexual dimorphism was evident with female skulls showing a higher incidence (8.7%) compared with male skulls (5.3%). The corresponding atlas vertebrae were normal. These craniovertebral anomalies may have clinical relevance for lesions at the foramen magnum.

Key words: Skull; occipital bone; basiocciput; foramen magnum; precondylar tubercles; atlas.

INTRODUCTION

Craniovertebral abnormalities have been recorded for many years in morphological and clinicoradiological studies (Kollmann, 1905; Gladstone & Erichsen-Powell, 1915; Bolk, 1921; Oetteking, 1923; Gladstone & Wakeley, 1925; List, 1941; Ingelmark, 1947; Hadley, 1948; McRae, 1953; Lombardi, 1961; Nicholson & Sherk, 1968; Putz, 1975; Shapiro & Robinson, 1976; Pia, 1983; Smoker, 1994).

The assimilation of various vertebrae into the occipital segments of the skull is responsible for the variable morphology of the craniovertebral region among vertebrates. A partial liberation of one of the vertebral elements which normally enter into the composition of the basiocciput results in an 'occipital vertebra' (Keith, 1948). A transient mesenchymal 'hypochordal bridge of the occipital vertebra' along the anterior margin of foramen magnum between the occipital condyles, observed in human embryos of 12.5–21.0 mm crown–rump length and completely absent by the 80 mm crown–rump length stage is mentioned (Ingelmark, 1947). Failure of complete disappearance of the hypochordal bridge during development may manifest as osseous formations in this craniocervical transition region (Ingelmark, 1947; Putz, 1975). These include the condylus tertius, processes basilares, enlarged massae lateralis, labia foraminis magni anteriora (Kollmann, 1905; Ingelmark, 1947; Putz, 1975), the third condyle, basilar processes, accessory bone elements separate or fused to the foramen magnum (Hadley, 1948; Lombardi, 1961) and precondylar tubercles (Oetteking, 1923; Marshall, 1955; Broman, 1957).

Precondylar tubercles are ventral rudiments of the occipital vertebra. A single midline or bilateral faceted tuberosity, a unilateral or bilateral nonarticular tubercle along the anterior margin of foramen magnum, spines or lamina continuous with the occipital condyles are documented as the presentations of these tubercles (Kollmann, 1905; Bolk, 1921; Oetteking, 1923; Marshall, 1955; Broman, 1957). Modern English anatomical texts usually do not mention these tubercles or do so in a general way. Williams et al. (1989) refer to a small depression immediately anterior to the occipital condyle, which may occasionally be replaced by a small precondylar tubercle.

On routine examination of the skull base there appeared to be more than the usual occurrence of precondylar tubercles. The present paper addresses

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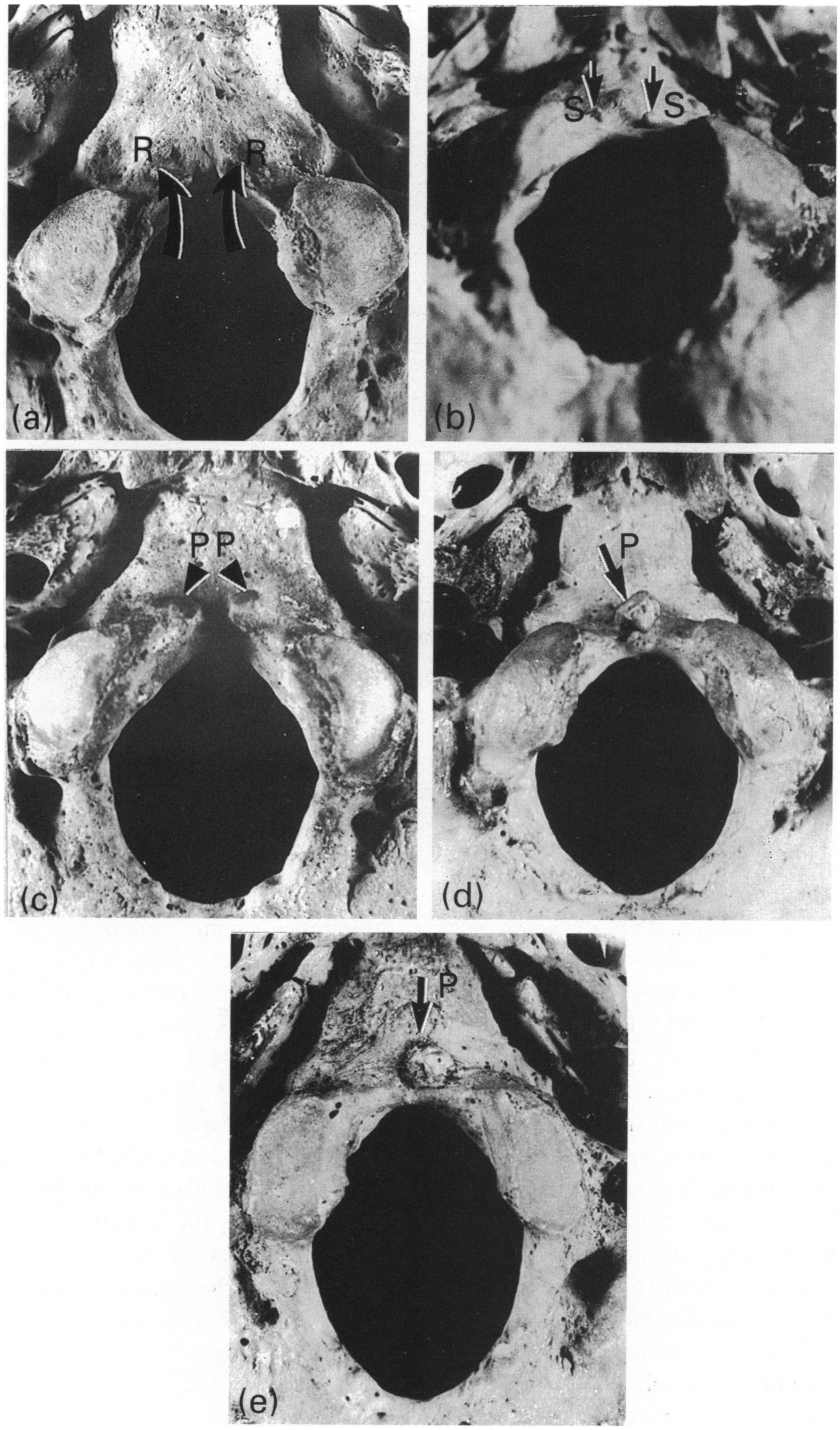

Fig. (*a*) Type I precondylar tubercles. Arrows indicate bilateral ridges (R). (*b*) Type II precondylar tubercles. Arrows indicate spines (S), larger on the left. (*c*) Type II precondylar tubercles. Arrowheads show bilateral faceted processes (P). (*d*) Type III precondylar tubercle. Arrow indicates faceted process (P). (*e*) Type III precondylar tubercle. Arrow indicates single nonfaceted process (P).

the prevalence, forms of presentation and significance of precondylar tubercles in adult human skulls.

MATERIALS AND METHODS

The study was conducted on 265 dry Indian adult human skulls (173 male, 92 female) and the corresponding atlas vertebrae, available in the Department of Anatomy, Lady Hardinge Medical College, New Delhi, over a period of 5 years.

The inferior aspect of the basiocciput was examined for the occurrence of precondylar tubercles which consisted of bony elevations ranging from ridges near the anterior ends of occipital condyles to larger median or paramedian projections along the anterior border of foramen magnum (Fig.). Their location, number, size and presence of facets was noted. The size was evaluated subjectively, and ridges (Fig., *a*), spines (Fig., *b*) and processes (Fig., *c–e*) were classified as types I, II and III respectively.

The corresponding atlas vertebrae were also examined for any obvious malformation.

RESULTS

Observations regarding the size, incidence, location and faceting of the precondylar tubercles are presented in Table 1. Of the 265 skulls examined, 37 (14%) showed precondylar tubercles: 14 (5.3%) demonstrated Type I, 13 (4.9%) type II, and 10 (3.8%) type III tubercles. Type I and II precondylar tubercles were paramedian. Of the type III tubercles, 5 were median and 5 paramedian. Eighteen occiputs displayed these tubercles bilaterally and in 14 they were unilateral. Facets were seen on type III tubercles in 2 skulls (Fig. *c*, *d*).

Table 2 presents the incidence of precondylar tubercles according to sex. Of the 173 male skulls, 14 (5.3%) showed precondylar tubercles, while 23 (8.7%) were observed on the 92 female skulls examined. The corresponding atlas vertebrae showed normal adult morphology.

Table 2. *Incidence of precondylar tubercles according to sex*

Sex	Number of skulls	Precondylar tubercles	
		Number	%
Male	173	14	5.3
Female	92	23	8.7
Total	265	37	14.0

DISCUSSION

Berry & Berry (1967) and Berry (1975) regarded precondylar tubercles as nonmetric epigenetic anthropological markers to measure genetic distinctiveness or divergence between a pair of populations. Our results, showing a high prevalence of these tubercles, are comparable with Burmese skulls and those of the north-west coast of America (Berry, 1975) with evident sexual dimorphism and the same range of male and female skulls possessing the tubercles. Although the findings reported for White and African American female skulls (Broman, 1957) and female Polynesian skulls (Marshall, 1955) correspond to the Indian female skulls, their male counterparts show a relatively higher prevalence of tubercles than the male skulls of our study.

Putz (1975) considered that some isolated tubercles may be lost during maceration; the real prevalence of these tubercles is therefore higher than that established on the basis of a macerated skull series.

Opinions concerning the aetiology of precondylar tubercles are divided; some investigators have considered them as 'developmental relics' (Kollmann, 1905; Bolk, 1921; Ingelmark, 1947; Keith, 1948; Broman, 1957; Putz, 1975), while others have postulated ossification within the atlanto-occipital ligaments or that artificial deformation practices on adults such as 'head binding' may be responsible (Oetteking, 1923; Marshall, 1955; Hadley, 1956). Artificial deformation can be excluded in our study since it is not practised in India.

Table 1. *Size, incidence, location and faceting of precondylar tubercles*

Type	Number	%	Median	Paramedian		Facets
				Unilateral	Bilateral	
I (ridge)	14	5.3	—	6	8	—
II (spine)	13	4.9	—	5	8	—
III (process)	10	3.8	5	3	2	2
Total	37	14.0	5	14	18	

Besides being of anthropological and ethnological interest, these variants may be important in a clinical context. Accessory vertebral elements along the anterior margin of foramen magnum interposed between the basiocciput and atlas may reduce the circumference of the foramen or cause asymmetry (Nicholson & Sherk, 1968; Vinken & Bruyn, 1978). A complete persistent occipital vertebra may unite with the anterior arch of the atlas causing abnormal angulation between the clivus and atlanto–axial complex with subsequent ventral compression of the cervicomedullary junction. Enlarged median or paramedian bony masses ventral to the foramen may form a pseudojoint with the apical segment of the odontoid process or anterior arch of the atlas, thereby affecting the kinetic anatomy and integrity of the atlanto–occipital articulation (VanGilder et al. 1987). The identification and interpretation of static and dynamic biomechanical pathogenesis is a prerequisite for correct diagnosis and choice of the operative technique to be adopted (Pia, 1983).

It is noteworthy that congenital craniovertebral anomalies may initially remain clinically silent and manifest abruptly in adult life as a result of diminished compensatory mechanisms (List, 1941; Hadley, 1956; Vinken & Bruyn, 1978; VanGilder et al. 1987). Further, multiple other anomalies not infrequently coexist, thus contributing to a variegated clinical picture (Vinken & Bruyn, 1978; Pia, 1983; VanGilder et al. 1987). Magnetic resonance imaging (MRI) is well suited for evaluating the craniovertebral junction, because of its direct sagittal imaging capabilities. With the institution of routine MRI, diagnosis could be readily established (Smoker, 1994) and operative intervention carried out to alleviate the problem (Nagashima & Kubota, 1983). The widespread availability of MRI calls for a renewed understanding of the normal and variant autonomy of this region.

Our study furnishes morphological data on Indian skulls, providing an anatomical baseline to correlate the radiological findings with clinical presentations.

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