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Morphology of the articular processes of the sixth cervical vertebra in humans

With the exception of the 7th vertebra, both past and recent literature describe the lower cervical vertebrae as possessing similar morphological characteristics (Soemmering, 1794; Cruveilhier, 1862; Luschka, 1862; Henle, 1871; Braus-Elze, 1954; Romanes, 1981; Williams et al. 1989; Benninghof, 1994). Gross anatomical differences from the 3rd to the 7th cervical vertebrae comprise the shapes of the vertebral body and uncinate and spinous processes (Putz, 1976; Penning, 1988; Lang, 1990) and the more developed anterior tubercle and anterior root of the transverse process of the 6th cervical vertebra (C6) (Paturet, 1951). During routine examination of a series of dried skeletons, the articular processes (AP) of C6 were found to be distinct from the rest of the cervical vertebrae. The aim of this study was to confirm this unusual appearance of the C6 process by inspecting a sample of dried skeletons. We report the morphology of the AP of C6 in 76 well preserved complete adult skeletons (58 males, 18 females; age 31–77 y) and 5 young specimens from the Anatomical Institutes of Alicante, Valencia and Murcia (Spain) and Munich (Germany). Another 12 skeletons were excluded from the study due to arthritic changes in their cervical APs.

The superior articular process (SAP) of C3–C5 and their corresponding inferior articular process (IAP) were seen to be separated by a fine sulcus that serves as a landmark of the interarticular portion (Fig., panel a). In C6, the articular pillar was arranged craniocaudally in a 2-step manner (Fig., panel b), and a sharp incisure extending from the lateral third to half of the interarticular portion was seen to separate both AP (Fig., panels c, d). This incisure was sharply defined unilaterally (44%) or bilaterally (56%) and with few noteworthy left–right differences (Table) and was present in both young (Fig., c) and adult (Fig., d) specimens.

Five C6 vertebrae (3.1% of the total series) showed a sulcus in place of an incisure, while C5 vertebrae only exhibited the incisure in 12% of the cases. In C6 vertebrae the 2-step AP arrangement was observed in 92% of the processes versus 23.9% of the C5 vertebral series. In C7 the incisure was broader than in C6, and both AP were completely separated by the compact interarticular bony portion. The conical muscular process of C6 (Fig., e) was in turn located in the dorsocaudal region of the interarticular portion in 40% of cases. The remaining 60% exhibited an osseous tubercle or rough marks. Neither a process nor a tubercle was observed in vertebrae from children. C5 vertebrae possessed either rough marks or a tubercle in 12% of cases, while no process or tubercle was found on C7. An analysis of variance (ANOVA 1-way) was performed on an IBM PC using SPSS software. A P value of < 0.01 was considered statistically significant. We assessed the incidence of the 3 recognised features (2-step form, incisure and tubercle or process) from the C5 to C7 processes. Separate analysis of the processes (C5–C6; C5–C7; C6–C7) showed the highest probability (P < 0.001) to correspond combined to C6.

The articular surface of the SAP was oval in shape (52%), incompletely divided by 2 opposite incisures into 2 facets (40%) or rounded (8%). In the frontal view the lateral portion of the SAP was more elevated than the medial portion. In the sagittal view, the rostral portion of the process and its corresponding articular surface was more elevated than the posterior portion. The SAP was attached to the costotransverse process. In turn, the articular surface of the IAP was incompletely divided into 2 facets (50%), oval (44%) or rounded in shape (6%). In the frontal plane, the medial portion of the IAP was lower than the lateral portion, the IAP being located eccentric to the SAP.

The presence of these hitherto undescribed characteristics in the AP of C6 shows them to be particular in form and shape. The association of the 2-step arrangement of the AP, the incisure and the muscular process only occurs in this vertebra. An isolated vertebra could be identified as C6 if it possesses the first 2 above mentioned features, the muscular process being the complementary third characteristic. We believe these findings to be of anatomical and anthropological interest, particularly in contributing to identification procedures for isolated cervical vertebrae. Our material shows that the incisure is present in children. In this sense, the incisure probably develops during the prenatal and/or postnatal period, while the muscular process (Sato & Nakazawa, 1982) appears later as the result of mechanical forces. The above findings are also of interest in the clinical setting. In this sense, the incisure is in close relation with the articular capsule (Putz, 1981) and serves as an osseous channel for the dorsal ramus of the 6th cervical nerve. Arthritic deformations or osteophytic protusions within the channel present in the excluded skeletons could thus provoke irritation of the nerve branch.

C6 is the preferential site for the development of congenital spondylolisthesis, which is associated processes (Bellamy et al. 1974; Schneidau & Kendall, 1982; Ferrier et al. 1984; Edwards et al. 1991), a probable cause of progression towards neurological impairment (Hiroda et al. 1988). Black et al. (1991) reported a case of congenital spondylolisthesis of C6, with bony clefts at the pars interarticularis and a dysplastic articular pillar simulating a facet fracture-dislocation. Dysplastic processes are also associated to uni- or bilateral spondylolysis (Holland & Stolle, 1962; Azous et al. 1974; Schwartz et al. 1982; Forsberg et al. 1990; Jones & Sage, 1992). These ab-

Table. 6th cervical vertebra. Frequency and degree of development of the incisure*

<table>
<thead>
<tr>
<th>Incisure</th>
<th>0</th>
<th>+</th>
<th>++</th>
<th>+++</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articulated skeletons</td>
<td>2</td>
<td>22</td>
<td>15</td>
<td>—</td>
</tr>
<tr>
<td>(n = 76)</td>
<td>4</td>
<td>20</td>
<td>13</td>
<td>—</td>
</tr>
</tbody>
</table>

* 0, sulcus; +, moderate incisure; ++, sharp incisure; ++++, articular processes fully separated by the incisure.
normalities make it important to differentiate by means of radiological, computed tomographic and magnetic resonance explorations the morphological features of C6 vertebrae, in order to avoid confusion with hypoplastic processes or fractures.

ACKNOWLEDGEMENT

The authors are indebted to Prof. R. Putz, Anatomical Institute of Munich, Germany, for providing a part of the osteological material and for helpful comments during several stages of the study.

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REFERENCES


Fig. (a) Left-sided articular processes (AP) of the 3rd cervical vertebra. Line diagram (left upper corner) shows the dorsal sulcus. (b) Adult left 6th cervical vertebra. The incisure serves as a landmark for the interarticular portion and divides both superior and inferior articular processes. Line diagram (left upper corner) show the dorsal incisure. (c, d) Posterior view of an adult (c) and infant (d) 6th cervical vertebra, exhibiting bilateral incisures (white arrows). (e) Left muscular tubercle (white arrow) corresponding to a 6th cervical vertebra.

show the dorsal incisure. (c, d) Posterior view of an adult (c) and infant (d) 6th cervical vertebra, exhibiting bilateral incisures (white arrows). (e) Left muscular tubercle (white arrow) corresponding to a 6th cervical vertebra.


