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Formation of the vertebral arches of the cervical, thoracic and lumbar vertebrae in early human foetuses

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Fusion of the neural arches was studied in 6 serially sectioned human foetuses aged 9 and 10 weeks. In foetuses of 9 weeks, the completion of arches was observed in the cervical, upper thoracic, and middle thoracic regions of the vertebral column. During the 10th week of development, fusion of neural processes progresses in the lower thoracic and upper three lumbar vertebrae. (Folia Morphol 2010; 69, 3: 177–179)

Key words: human embryology, vertebral column, vertebral arches

INTRODUCTION

The embryonic development of the vertebral column has been widely investigated [7–11] and has been summarised by O'Rahilly and Meyer [12].

Detailed, well illustrated studies of the vertebral column, as a whole and particular regions of the column, at the end of the embryonic period have been performed by O'Rahilly et al. [13–16].

Bagnal et al. [1–5] studied the foetal vertebral column by radiography, with particular attention paid to longitudinal growth and ossification centres in the vertebral column.

The aim of the present study is the examination of fusion of the neural arches in the cervical, thoracic, and lumbar regions of the vertebral column in foetuses aged 9 and 10 weeks.

MATERIAL AND METHODS

Serial sections of six human foetuses aged 9 (three foetuses) and 10 (three foetuses) weeks were studied. The foetuses belong to the Collection of the Department of Anatomy of the University of Medical Sciences in Poznań. Sections of thickness 5 and 10 μm were made in the horizontal plane. The stains employed included haematoxylin and eosin, and cresyl violet (according to Nissl), according to Mallory method, and Bodian's protargol.

RESULTS

In all investigated foetuses, the vertebrae form the cartilaginous column and ossification was not detectable.

In the nine-week-old foetuses the neural processes of the vertebrae extended dorsally on each side of the neural tube and they united to complete the neural arches which formed the vertebral arches. This completion of the arches was observed in the cervical, upper thoracic, and middle thoracic regions of the vertebral column (Figs. 1–3).

Fusion of the neural processes appeared first on their surface facing the dorsal part of the spinal cord. The ends of these processes were still separated and acquired a bifurcated shape (Figs. 1, 2). This was particularly evident in the cervical and upper thoracic vertebrae. In the lower thoracic and lumbar regions of the spinal cord the neural processes were close to each other but they were still separated (Fig. 4).

In foetuses aged 10 weeks, fusion of the neural processes was observed in all thoracic and up-

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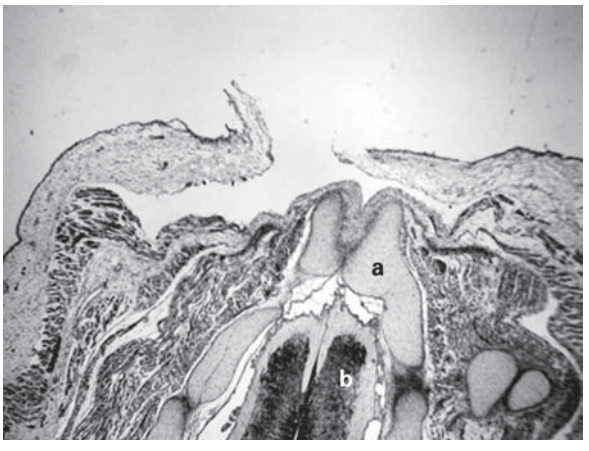

Figure 1. Horizontal section of cervical region in foetus of 9 weeks. Stained with cresyl violet; × 40; a — neural process, b — spinal cord.

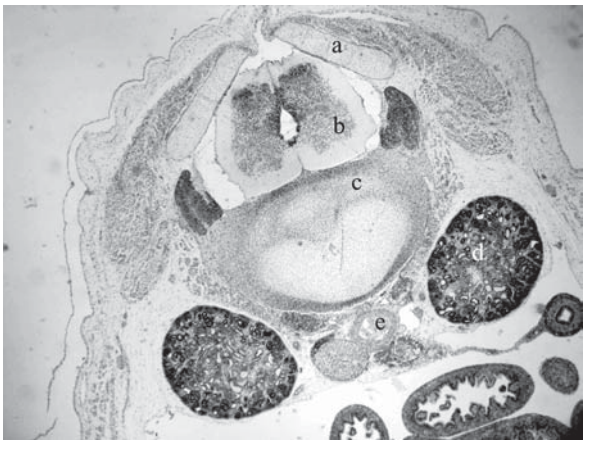

Figure 4. Horizontal section of upper lumbar region in foetus of 9 weeks. Stained with cresyl violet; × 40; a — neural process, b — spinal cord, c — intervertebral disc, d — kidney, e — abdominal aorta.

Figure 2. Horizontal section of upper thoracic region in foetus of 9 weeks. Stained with cresyl violet; × 40; a — body of vertebra, b — rib, c — neural process, d — spinal cord, e — transverse process.

Figure 5. Oblique horizontal section of upper thoracic region in foetus of 10 weeks. Stained with cresyl violet; × 40; a — neural process, b — transverse process, c — ribs, d — spinal cord, e — spinal ganglion.

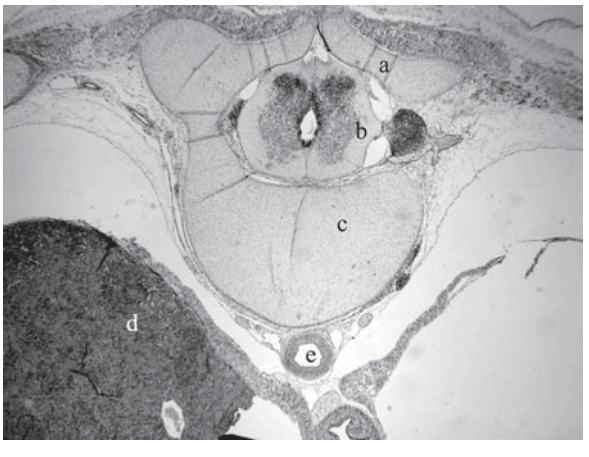

Figure 3. Horizontal section of middle thoracic region in foetus of 9 weeks. Stained with cresyl violet; × 40; a — neural process, b — spinal cord, c — body of vertebra, d — liver, e — thoracic aorta.

per three lumbar vertebrae (Figs. 5, 6). In lower 2 lumbar vertebrae the neural processes were close to the median plane but were not fused yet. The neural processes in this region were completed by the membrana reuniens dorsalis, which closed the vertebral canal from surface epithelium and subjacent mesenchyme.

The shape of the fused ends of the neural processes resembled that of the foetuses aged 9 weeks.

DISCUSSION

Condensation of the sclerotomal mesenchyme around the notochord is the earliest primordium of the skeleton and is frequently referred to as the blastema stage. This stage is followed by the cartilaginous stage which begins early in the 6th week. This blastema anlage forms the centrum which lies ven-

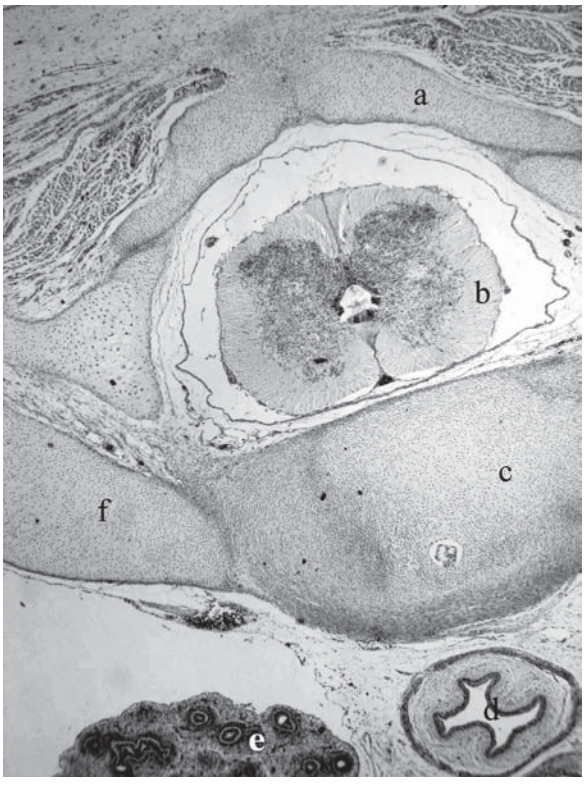

Figure 6. Horizontal section of lower thoracic region in foetus of 10 weeks. Stained with cresyl violet; × 40; a — neural process, b — spinal cord, c — body of vertebra, d — oesophagus, e — lung, f — rib.

tral to the neural tube and forms the primordium of most of the vertebral body.

According to O'Rahilly and Müller [17], "In terms of adult anatomy, the body of a vertebra includes the centrum and small part of the neural arch. Correspondingly, the vertebral arch is slightly less extensive than the neural arch. A rib articulates with the neural arch and not with the centrum."

From the dorsolateral angles of the centrum, the neural arch grows to enclose the spinal cord.

By the end of the embryonic period, the vertebral column presents a normal spina bifida totalis. The membrana reuniens dorsalis extends between the neural processes.

According to Bardeen [6], the neural arches fuse in foetuses of 50 mm crown-rump length.

In the present study it was found that the fusion of the neural arches progresses craniocaudally. At 9 weeks the completion of neural arches was observed in the cervical, upper thoracic, and middle thoracic regions. In foetuses aged 10 weeks this fusion was found in all thoracic and upper lumbar vertebrae.

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