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The role of the notochord in amniote vertebral column segmentation

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Abstract

The vertebral column is segmented, comprising an alternating series of vertebrae and intervertebral discs along the head-tail axis. The vertebrae and outer portion (annulus fibrosus) of the disc are derived from the sclerotome part of the somites, whereas the inner nucleus pulposus of the disc is derived from the notochord. Here we investigate the role of the notochord in vertebral patterning through a series of microsurgical experiments in chick embryos. Ablation of the notochord causes loss of segmentation of vertebrae and discs. However, the notochord cannot segment in the absence of the surrounding sclerotome. To test whether the notochord dictates sclerotome segmentation, we grafted an ectopic notochord. We find that the intrinsic segmentation of the sclerotome is dominant over any segmental information the notochord may possess, and no evidence that the chick notochord is intrinsically segmented. We propose that the segmental pattern of vertebral bodies and discs in chick is dictated by the sclerotome, which first signals to the notochord to ensure that the nucleus pulposus develops in register with the somite-derived annulus fibrosus. Later, the notochord is required for maintenance of sclerotome segmentation as the mature vertebral bodies and intervertebral discs form. These results highlight differences in vertebral development between amniotes and zebrafish and some other teleosts, where the notochord dictates the segmental pattern. The relative importance of the sclerotome and notochord in vertebral patterning has changed significantly during evolution.