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Notes on the development of the lamina terminalis in the human embryo

by

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Overview The development of the lamina terminalis (LT) is like the development of the floor plate of the neural tube, with adjacent regions on the left and right (i.e., anlagen of the ventral horns and covering white matter) mimicking the growth of the telencephalic vesicles.

The cranial neuropore closes between Carnegie Stages (CS) 10 and 12. Two surfaces result from closure after CS12: ectoderm and neuroepithelium of the prosencephalon. The latter representing the LT, which lies between the site of the future optic chiasm and the cerebral paraphysis.

The midline growth resistance that impedes initially the LT is the enlarging heart, which is beating against the rostral end of the prosencephalon.

From CS10 onwards, branches from the two aortas play a role in formation of the LT by allowing the prosencephalic surface to expand rostrodorsally while thickening rostrobasally, especially in the region of the optic chiasm. Blechschmidt (1961, 2004) describes how this happens due to the restraint caused by tension in the aortas acting as a cerebral halter (gubernaculum). The neural tube continues to grow rostrally, 'sliding past' the optic anlagen in a 2.57 mm embryo (CS12) because the optic vesicles are already anchored to (i.e., are in metabolic relation with) the ectoderm of the future lens placodes.

The width and height of the LT increases throughout embryonic and fetal development. In the adult, the LT is a thin triangular membrane with a base about 13 mm wide near the optic chiasm and a midline height to its apex near the corpus callosum of about 8 mm.

In the embryo, the LT thickens initially and so becomes a site where there is reduced capacity for areal growth. Metabolic by-products accumulate in tiny spaces or interstices in the thick epithelium, like the way interstices arise in the epithelium of the optic stalk.

As the LT broadens in the embryo during growth-widening of the head, the interstices, which are initially perpendicular to the vector of epithelial thickening, become aligned transversely.

In turn, this alignment of fluid-filled spaces permits the transverse growth of neurites and dendrites associated with the metabolism of cells in more lateral parts of the former prosencephalon, in accordance with the growth dynamics of neurites and dendrites (Blechschmidt, 2004). Neurites or dendrites could grow into the spaces in a similar fashion to the neurites of retinal ganglion cells growing into the interstices of the optic stalk. In the case of the LT, the 'decision' as to whether a growing part of a nerve cell become a neurite or a dendrite is determined by asymmetry in the growth of the left and right telencephalic vesicles – the growth in area and wall thickness of a hemisphere oscillates within a hemisphere and also from left to right across the midline (Blechschmidt, 2004). Collectively, the new nerve fibres in the LT constitute the anlage of the first cerebral commissure (anterior commissure).

Furthermore, as the LT epithelium thickens, it sucks in a powerful blood supply from the basal connective tissue bed, i.e., from the basal meninges, which are already highly vascularised. These vessels further impede areal growth in the LT, even more so as the cerebral hemispheres are now enlarging rapidly on the right and left sides of the LT.

The overall constraints (bilateral cerebral impediment, anteroventral vascular impediment, tension in anterior commissure) are so great that a unique interface arises between the vessels and the cells of the LT, namely the vascular organ of the LT. This becomes associated functionally with similar developments in other circumventricular organs (paraphysis, epiphysis, hypophysis, etc.).

The growth in thickness and area of the LT is soon overtaken by the volume growth of its adjacent structures, particularly the cerebral hemispheres, and so, with time, the LT becomes relatively smaller and thinner.

The LT is therefore a consequence of initial epithelial thickening in the basal midline of the prosencephalon due to asymmetry of cerebral growth and anterior resistance during the ascent of the neural tube. Thus, the LT is a manifestation of axial asymmetry in growth between the head and rump of the embryo (the cranial end of the neural tube is always broader than the anticranial end). The midline anchoring of the LT against resistance of the ectoderm permits the formation of the two cerebral hemispheres on either side (i.e., the prosencephalon does not bifurcate of its own accord).

The 'anchoring' of the LT is strengthened by a new retension field in the form of the falx cerebri attached to the crista galli. Later, a pool of fluid arises on the external surface of the LT within the arachnoid mater, the optic cistern.

Blechschmidt E. *The Stages of Human Development Before Birth,* Basel: Karger, 1960
Blechschmidt E. *The Ontogenetic Basis of Human Anatomy. A Biodynamic Approach to Development from Conception to Birth*, San Francisco: North Atlantic Books, 2004