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Tangential migration of neocortical neurons in early human foetuses

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The aim of the present study is to describe the tangential migration of cortical neurons in early human foetuses aged 9–11 weeks. Histological sections showed that in this early period of development most of the neurons migrate along radial glia, but there is also tangential migration, especially from the lateral eminence.

key words: human neuroembryology, foetal period, cerebral cortex, migration

INTRODUCTION

In the prenatal development of the cerebral cortex the ventricular zone gives rise, through successive rounds of cell division and migration, to the postmitotic neurons that comprise the adult cortical layers. The appearance of the cortical plate at the end of the embryonic period is a fundamental event in the development of the hemispherical wall. It results in differentiation of the hemispherical wall into the following layers: ventricular, subventricular, intermediate, subplate, cortical plate, and marginal. It is known that neocortical neurons migrate mainly along radial glia, perpendicularly to the cortical surface [2, 5–7]. The aim of the paper is to trace two types of neuronal migration.

MATERIAL AND METHODS

Investigations were performed in 5 human foetuses aged from 9 to 11 weeks. The age of the foetuses was estimated according to C-R length. The foetuses were from the Collection of the Department of Anatomy in Poznań. The foetuses were fixed in 10% formalin and were embedded in toto in paraplast. Serial sections of heads were made in three planes: frontal, sagittal, and horizontal. The sections were stained with toluidine blue, haematoxylin and eosin, and were impregnated with Bodian's protargol and silver nitrate.

RESULTS

In investigating the foetuses all layers of the hemispherical wall were observed, viz. ventricular, subventricular, intermediate, subplate, cortical plate, and marginal. The intermediate layer is subdivided into two zones: internal and external. The internal zone consists of irregular groups of densely packed migrating cells, forming cone-like bands, which taper toward the surface of the hemisphere (Fig. 1a). The external zone is wider and is formed by scattered cells and many nerve fibres directed horizontally. In the intermediate layer processes of radial glial cells running vertically, are clearly visible (Fig. 1b). Two types of cortical migration were found, radial and tangential. The greatest numbers of neurons reach the cortex along the fibres of the radial glia. The stream of migrating cells is directed perpendicularly to the cortical surface. The neurons migrate from the intermediate layer of the hemispherical wall to the cortical plate. The radial glia form a special "framework" for migrating cells (Fig. 1b). It was observed that neurons also migrate from the lateral eminence, which is the primordium of telencephalic nuclei. These neurons migrate to an adjacent part of the cortical plate and are directed almost parallel to the cortical surface (Fig. 2a). The migrating cells form cell aggregates resembling chains (Fig. 2b). From

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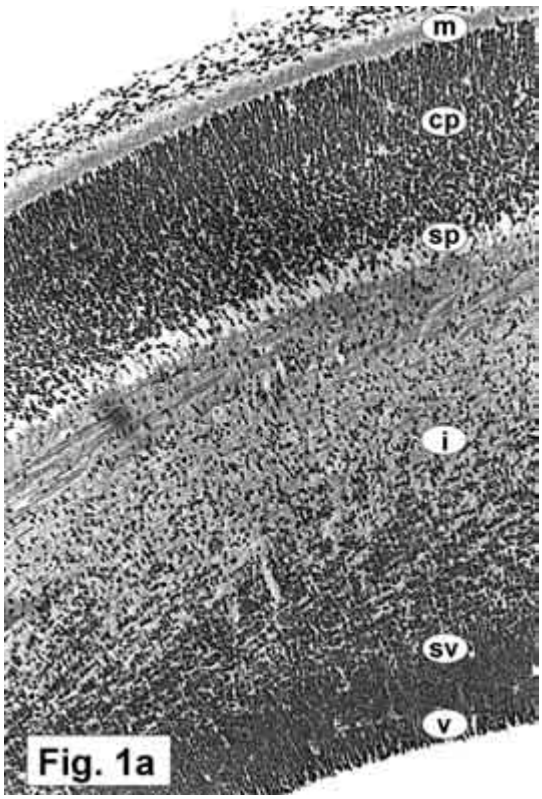


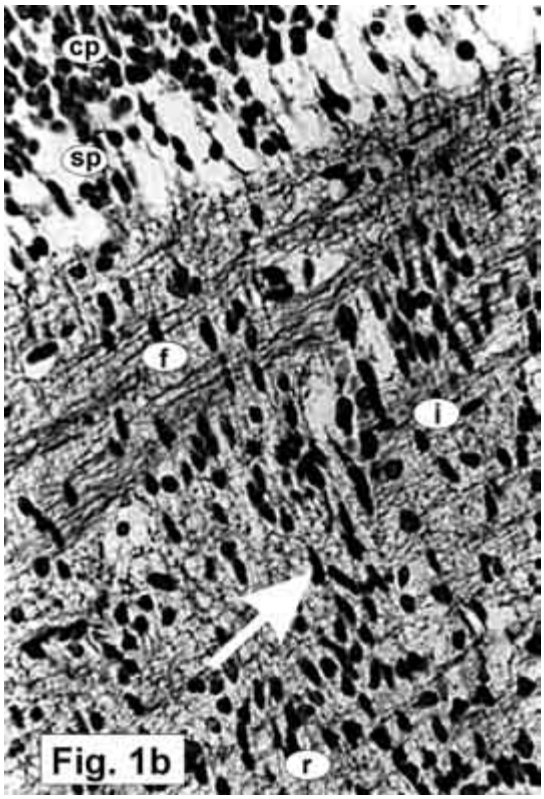
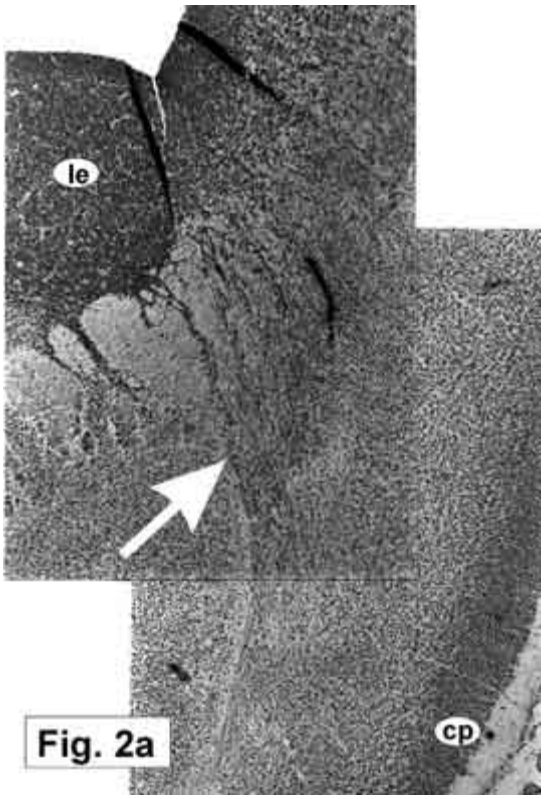


Figure 1a, b. Radial migration in foetus aged 11 weeks; arrow — migrating cells, m — marginal layer, cp — cortical plate, sp — subplate, i — intermediate layer, sv — subventricular layer, v — ventricular layer, f — nerve fibres, r — radial glia.



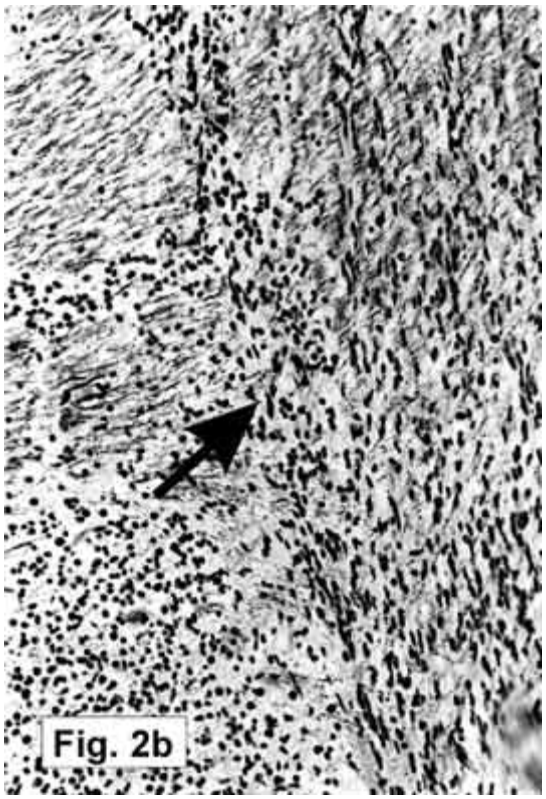


Figure 2a, b. Tangential migration in foetus aged 11 weeks; arrow — migrating cells, le — lateral eminence, cp — cortical plate.

this study it is evident that in the development of the cerebral cortex tangential migration also occurs.

DISCUSSION

The migration of neurons and the appearance of the cortical plate result in differentiation of the hemispherical wall into six layers: ventricular, subventricular, intermediate, subplate, cortical plate, and marginal [1, 4]. The cortical layers are generated in an inside-out fashion, with cells destined for the deepest layer born progressively later [8]. Hatten [2], Rakic [5], Roberts et al. [6], and Sidman and Rakic [7], investigating cortical migration, described only radial migration along the fibres of radial glia. Luskin [3] observed tangential migration parallel to the cortical surface only to the olfactory bulb. During the last decade experimental studies have revealed that some percentage of neurons to the cerebral cortex migrate tangentially [9, 10]. The migrating cells do not follow radial glia and they move in association with each other. In the present study the tangential migration of neurons from the lateral eminence to the neocortex has been observed as well as radial migration.

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