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Mechanisms underlying the development and evolution of the mammalian cerebral cortex

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Abstract. The cerebral cortex has markedly changed during evolution. Using our technique, here we examined the mechanisms regulating the number of astrocytes in the cerebral cortex.

Key words: cerebral cortex, evolution, development.

Conflict of interest. The authors declare the absence of obvious and potential conflicts of interest associated with the publication of this article.

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Objectives. The cerebral cortex has markedly changed during evolution. The cerebral cortex has become larger, and gyri were formed on the surface of the cerebral cortex. The number of neurons and glial cells in the cerebral cortex has increased significantly. Although these changes in the cerebral cortex are considered to be important for the acquisition of higher brain functions, the mechanisms underlying these changes remain unclear. Therefore, we utilized ferrets, which have relatively large and gyrencephalic cerebral cortex. To manipulate gene expressions in the ferret cerebral cortex, we previously established in utero electroporation techniques for ferrets [1-3]. Using our technique, here we examined the mechanisms regulating the number of astrocytes in the cerebral cortex [4].

Results. Using RNA-seq analyses and in situ hybridization, we found that FGF1 and FGF receptors were highly expressed in ferret astrocytes. FGF1 stimulated proliferation of cultured astrocytes, and an FGF receptor inhibitor suppressed astrocyte proliferation, suggesting that FGF1 regulates astrocyte proliferation in an autocrine/paracrine manner. Interestingly, the expression level of FGF1 was higher in ferret astrocytes than in mouse astrocytes. This result suggests that the expression level of FGF1 determines the number of astrocytes in various mammals. We also introduced FGF1 in the mouse cerebral cortex and found that the number of astrocytes were markedly increased, suggesting that FGF1 regulates the number of astrocytes in vivo.

Conclusions. Taken together, our findings may indicate that the expression levels of FGF1 was increased during evolution, and as a result, the number of astrocytes increased. Our technique for the ferret cerebral cortex should be useful for investigating the mechanisms underlying the development and evolution of the cerebral cortex.

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