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ORIGINAL ARTICLE

Expression of aquaporin-7 and aquaporin-9 in tanycyte cells and choroid plexus during mouse estrus cycle

Expression de l'aquaporine-7 et de l'aquaporine-9 dans les tanycytes et les plexus choroïdes au cours du cycle œstral chez la souris

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KEYWORDS

AQP-7;
AQP-9;
Tanycyte cells;
Mouse;
Estrus cycle

Summary Tanycytes are special ependymal cells located in the ventrolateral wall and floor of the third ventricle having processes extending nuclei that regulate reproductive functions and around of vessels in median eminence. The aquaporins (AQPs) are a family of transmembrane proteins that transport water and glycerol. AQP-7 and -9 are permeable to other small molecules as glycerol and therefore called aquaglyceroporins. In this study, we aimed to show localization of AQP-7 and -9 in epithelial cells of choroid plexus and tanycytes during female mouse estrus cycle. AQP-7 and -9 proteins were detected in $\alpha 2$ and $\beta 1$ tanycytes in proestrus stage. Interestingly, there is no staining in estrus stage in any type of tanycytes. We observed weak immunoreactivity in $\alpha 1$, $\alpha 2$ and $\beta 1$ tanycyte cells in metestrus stage for AQP-7 and $\alpha 1$ for AQP-9 protein. AQP-7 and -9 showed intense immunoreactivity in $\alpha 2$, $\beta 1$ and $\beta 2$ tanycyte cells during diestrus stage. Consequently, AQP-7 and -9 showed differential staining pattern in different stages of mouse estrus cycle. In the light of our findings and other recent publications, we suggest that AQP-7 and -9-mediated glycerol transport in tanycyte cells might be under hormonal control to use glycerol as a potential energy substrate during mouse estrus cycle.
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MOTS CLÉS

AQP-7 ;
AQP-9 ;

Résumé Les tanycytes sont des cellules épendymaires spécialisées situées dans la paroi ventrolatérale et le plancher du troisième ventricule. Elles ont des prolongements s'étendant aux noyaux qui régulent les fonctions reproductives ainsi qu'autour des vaisseaux situés dans l'éminence médiane. Les aquaporines (AQPS) sont une famille de protéines transmembranaires

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<http://dx.doi.org/10.1016/j.morpho.2016.09.001>

1286-0115/© 2016 Published by Elsevier Masson SAS.

Please cite this article in press as: Yaba A, et al. Expression of aquaporin-7 and aquaporin-9 in tanycyte cells and choroid plexus during mouse estrus cycle. Morphologie (2016), <http://dx.doi.org/10.1016/j.morpho.2016.09.001>

Tanycyte ;
Souris ;
Cycle œstral

qui transportent l'eau et le glycérol. Les AQP-7 et -9 appelées aquaglycéroporines sont perméables à d'autres petites molécules que le glycérol. Dans cette étude, nous avons cherché à montrer la localisation des AQP-7 et -9 dans les cellules épendymaires des plexus choroïdes et dans les tanycytes au cours du cycle œstral de la souris femelle. Les protéines AQP-7 et -9 ont été détectées dans les tanycytes $\alpha 2$ et $\beta 1$ au stade proœstrus. À noter, l'absence de coloration à aucun stade de l'œstrus dans tous les types de tanycytes. Nous avons également observé une faible immunoréactivité dans les tanycytes $\alpha 1$, $\alpha 2$ et $\beta 1$ au stade de métœstrus pour AQP-7 et $\alpha 1$ pour la protéine AQP-9. AQP-7 et -9 ont montré une immunoréactivité intense dans les tanycytes $\alpha 2$, $\beta 1$ et $\beta 2$ pendant le diœstrus. Par conséquent, AQP-7 et -9 présentaient une répartition différente de leur détection selon différents stades du cycle œstral de la souris. Une étude récente suggère que le transport du glycérol par AQP-7 et de -9 dans les tanycytes peut se trouver sous contrôle hormonal pour utiliser le glycérol comme un substrat énergétique potentiel au cours du cycle œstral de la souris.

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Introduction

Choroid plexus is a secretory process consist of vascular tela choroidea and specialized ependymal cells in all cerebral ventricles where cerebrospinal fluid (CSF) produced and secreted. Epithelial cells of the choroid plexus produce more than two thirds of CSF and blood-CSF barrier at the choroid plexus is formed. Thus, choroid plexus regulates the molecular content of CSF. Therefore, it has important place for water transport in central nervous system (CNS).

Specialized ependymal cells called tanycytes are elongated bipolar cells located the infundibular recess in the floor of the third ventricle and having processes extending deep into the hypothalamus. Tanycyte cells are responsible from transfer of chemical signals from cerebrospinal fluid (CSF) to central nervous system (CNS) and they extend a long process contacting either blood vessels in the mediobasal hypothalamus or the median eminence. Tanycytes function as a shuttle between CSF and the portal capillaries and may connect the CSF to neurendocrine events. According to their location, morphology, cytochemistry, ultrastructure and function, four different subtypes of tanycyte cells $\alpha 1$, $\alpha 2$, $\beta 1$ and $\beta 2$ have been identified [1,2] (Fig. 1). Different types of tanycytes use different signal mechanisms to transport molecules. Therefore, these subtypes have functional differences expressing differentially important molecules.

Aquaporins (AQPs), presenting in all life forms, are members of a large family of integral membrane proteins which mainly facilitate water transport across cell membranes [3] and in some cases, water and small solutes. Thirteen members of the AQP family designated AQP0–AQP-12 have been identified so far [4]. AQP-0, AQP-1, AQP-2, AQP-4, AQP-5, AQP-6 and AQP-8 are function as water channels; but, AQP-0, AQP-1 and AQP-6 are also permeable for nitrate and chloride ions, and AQP-8 ammonia [5,6]. AQP-3, AQP-7, AQP-9 and AQP-10 are described as aquaglyceroporins, a subfamily usually permeable to water, glycerol and urea, and to a limited number of small neutral solutes [5,7]. AQP-9 is a neutral solute channel, permeable to water, glycerol, urea, purines, pyrimidines and monocarboxylates [8]. AQP-7 and AQP-9 are also able to transport arsenite [9].

Tanycytes can participate in the release of gonadotropin-releasing hormone (GnRH) to the portal blood by expressing

estrogen receptors, absorbing molecules from the CSF, and providing signal(s) to the GnRH neurons. Rodriguez et al. showed that removal of tanycytes prevents the pulse of GnRH release into the portal blood, the peak of luteinizing hormone, and ovulation [2]. During the ovarian cycle, under conditions of low gonadotropin output, GnRH-secreting axon terminals are completely surrounded or engulfed by tanycytes, which prevent direct access to the vascular wall and thus create a diffusion barrier impeding GnRH entry into the pituitary portal circulation [10]. The tanycytes are known to locally modulate gonadotropin release (GnRH) in the median eminence during the estrus cycle [11].

AQPs have taken very important place in studies especially related to different types of brain diseases. In this study, we hypothesized that AQP-7 and -9 might show different expressional pattern depending on estrus cycle stages. Therefore, the aim of our study was to evaluate the localization of AQP-7 and -9 in tanycyte cells and epithelial cells of choroid plexus during mouse estrus cycle. In the future, AQPs may represent a promising target for development of new therapeutic strategies for cancer and neurological diseases.

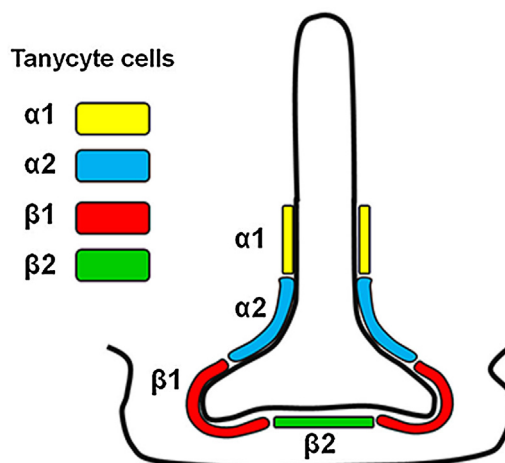


Figure 1 Schematization of tanycyte cells localization. Schéma montrant la localisation des tanycytes.

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