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The influence of the menstrual cycle on the result of brain examination with hydrogen magnetic resonance spectroscopy – a pilot study

Wpływ cyklu miesięcznego na wynik badania mózgu za pomocą spektroskopii protonowej rezonansu magnetycznego – badanie pilotowe

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Abstract

Background and purpose: Hydrogen magnetic resonance spectroscopy (^{1}HMRS) is nowadays one of the basic tools for noninvasive brain metabolism assessment. The study focuses on the important problem of the influence of hormone fluctuation during the menstrual cycle on brain metabolism, assessed by ^{1}HMRS for clinical diagnostics.
Material and methods: In 11 healthy regularly menstruating women, ^{1}HMRS was performed at the start (phase I), in the middle (phase II) and at the end (phase III) of the menstrual cycle. The relative concentration ratios of 12 brain metabolites in every woman in all cycle phases were examined, in 6 different volumes of interest (VOIs). Finally, statistically significant differences in relative metabolite ratios between the phases examined in given locations were sought.
Results: Statistically significant relations between menstrual cycle phases and relative ratios of 4 metabolites – Lac/Cr, NAA/Cr, Glx1/Cr and Glx2/Cr – in different brain locations were found. In all locations, mean NAA/Cr ratios were greater in phase I compared to the other phases. A similar relationship was found for Glx1/Cr ratio in one location (left occipital lobe). For Lac/Cr and Glx2/Cr ratios, a higher mean ratio value was obtained in phase II compared to phases I and III in the right occipital lobe and left basal ganglia, respectively.

Streszczenie

Wstęp i cel pracy: Spektroskopia protonowa rezonansu magnetycznego (^{1}HMRS) jest obecnie jednym z podstawowych narzędzi nieinwazyjnej oceny metabolizmu mózgu. Praca dotyczy istotnego problemu wpływu zmian hormonalnych w trakcie cyklu miesięcznego na metabolizm mózgu, oceniany dla celów diagnostyki klinicznej za pomocą ^{1}HMRS.
Materiał i metody: U 11 zdrowych, regularnie miesiączkujących kobiet wykonano badanie ^{1}HMRS na początku (faza I), w środku (faza II) i na końcu (faza III) cyklu miesięcznego. U każdej z kobiet we wszystkich powyższych fazach oceniano względne stężenia 12 metabolitów mózgu w 6 różnych obszarach zainteresowania (VOI). Dla każdej lokalizacji poszukiwano istotnych statystycznie różnic we względnych stężeniach metabolitów w poszczególnych fazach cyklu.
Wyniki: Stwierdzono istotne statystycznie zależności między fazą cyklu miesięcznego a względnymi stężeniami 4 metabolitów: Lac/Cr, NAA/Cr, Glx1/Cr oraz Glx2/Cr w różnych lokalizacjach. We wszystkich lokalizacjach stężenia NAA/Cr były większe w fazie I w porównaniu z pozostałymi fazami. Podobną zależność zaobserwowano dla stężenia Glx1/Cr w jednej lokalizacji (lewy płat potyliczny), natomiast dla stężeń Lac/Cr i Glx2/Cr, odpowiednio w prawym płacie potylicznym i lewych jądrach podstawy, stwierdzono większe wartości w fazie II w porównaniu z fazami I i III.

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Conclusions: Menstrual cycle phase should be considered in planning a date and interpretation of ^{1}HMRS examination, performed for the verification of a disease manifesting as brain metabolite disturbances in the ^{1}HMRS spectrum.

Key words: menstrual cycle, brain metabolism, ^{1}HMRS.

Wnioski: Faza cyklu miesięcznego powinna być uwzględniana przy wyznaczaniu daty i interpretacji badania ^{1}HMRS przeprowadzanego w celu weryfikacji choroby manifestującej się zaburzeniami poziomów metabolitów mózgu w widmie ^{1}HMRS.

Słowa kluczowe: cykl miesięczny, metabolizm mózgu, ^{1}HMRS.

Background and purpose

According to the World Health Organization (WHO) definition, the menstrual cycle is a term for cyclical changes in a woman's body under the influence of fluctuating levels of hormones of the hypothalamic-hypophyseal-ovarian axis – hypothalamus, pituitary gland, ovaries – from menarche to the last menstruation before menopause [1].

Previous papers in the field of gynecological endocrinology concerning the female hormonal system, the physiology of the menstrual cycle and its disturbances, as well as diseases resulting from improper functioning of the linked gland system, present mutual relationships between the glands and their products relatively precisely, starting from central nervous system functions and ending at ovarian activity [1,2]. The reverse direction, that is, menstrual cycle impact on brain functions, has not been precisely analyzed till now. However, it was found that the cycle significantly influences the central nervous system [3-8].

The technique enabling *in vivo* assessment of biochemical composition of tissues in selected brain locations is hydrogen magnetic resonance spectroscopy (^{1}HMRS). In spite of a very limited set of metabolites available for *in vivo* measurement, nowadays this method is coming to be seen as one of the main imaging tools for brain metabolism assessment [9-16].

Until now, only a few papers concerning this issue have been presented and no systematic research has been undertaken, including comparison of the broad set of metabolites identified in brain ^{1}HMRS of healthy women in various locations and during different menstrual cycle phases [17-21].

It seems important to know all the physiological processes, including the menstrual cycle, affecting the natural variability of ^{1}HMRS spectra obtained by commonly available 1.5 T magnetic resonance (MR) systems, because investigation of this issue is important for the analysis of ^{1}HMRS spectra used to differentiate physiological and pathological processes [10-12].

This study, therefore, focuses on the influence of hormonal fluctuation during the menstrual cycle on brain metabolism. The detection of possible relationships between brain metabolite changes and the menstrual cycle phases ought to be an important element to consider during ^{1}HMRS assessment for clinical diagnostics. Additionally, the results obtained may be a valuable data source in extending knowledge in the field of gynecological endocrinology.

Material and methods

The material comprised 11 healthy regularly menstruating women. The women were taking no hormonal drugs, including contraceptives. In all subjects, neurological or psychiatric disorders and brain trauma in history were excluded. Average age was 24.3 ± 3.8 years (22 to 29 years).

All women were non-smokers and, for 24 hours prior to the examinations, they were not allowed to drink alcohol to avoid the impact of smoking and alcohol on brain metabolite levels [20,22-26].

The study was accepted by the local bioethical committee. Informed consent was obtained from all the patients in the study after the nature of the procedure had been fully explained.

Women were examined three times: (a) at the start of the menstrual cycle (first to fifth cycle day – phase I), (b) in the middle of the menstrual cycle (13^{th} to 16^{th} cycle day – phase II), (c) at the end of the menstrual cycle (25^{th} to 28^{th} cycle day – phase III).

Examinations were performed using the MR Signa Excite 1.5 T system and data were processed using the SAGE software (GE Healthcare).

Each woman was placed in the supine position with her head inside the sending/receiving coil. To properly locate the volumes of interest (VOIs), T2-weighted axial localizers were first obtained (TE 88.2 ms, TR 4000.0 ms, slice width 5 mm, gap 0 mm).

Single-voxel spectroscopy (SVS) was used in the procedure. Six brain VOIs were selected in the following