

ASSESSMENT OF THE IMPACT OF RETROCEREBELLAR CYSTS IN THE BRAIN ON THE CEREBROSPINAL FLUID SYSTEM AS A CRITERION OF FITNESS FOR FLIGHT

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Retrocerebellar cysts of the brain represent the aspect that is important for determination of fitness for flight. The study was aimed to assess their impact on the pilot performance by conducting comparative analysis of MRI data of the first-year cadets and experienced pilots. We assessed the prevalence of retrocerebellar cysts among cadets and pilots, conducted non-contrast brain MRI, and compared the major academic and physical performance indicators, along with the results of professional psychological screen. The prevalence of retrocerebellar cysts among first-year cadets was 8.2%. High prevalence of asymptomatic retrocerebellar cysts among experienced pilots was revealed (two cases out of five). The intergroup comparison of indicators makes it possible to draw a conclusion about probable minor impact of such changes on fitness for flight. Further research is required to clarify the mechanisms underlying the impact of retrocerebellar cysts on the pilot performance and develop appropriate guidelines for medical boards.

Keywords: military medical examination, cerebrospinal fluid system, neuroimaging, cadets, pilots

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ОЦЕНКА ВЛИЯНИЯ РЕТРОЦЕРЕБЕЛЛЯРНЫХ КИСТ ГОЛОВНОГО МОЗГА НА ЛИКВОРНУЮ СИСТЕМУ КАК КРИТЕРИЙ ГОДНОСТИ К ЛЕТНОЙ РАБОТЕ

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Ретроцеребеллярные кисты головного мозга представляют собой важный аспект для определения пригодности к летной работе. Целью исследования было оценить их влияние на летную работу через сравнительный анализ данных МРТ курсантов первого курса и летчиков с опытом. Были выполнены анализ встречаемости ретроцеребеллярных кист у курсантов и летчиков, проведение МРТ ГМ без контрастного усиления, сравнительное исследование основных академических и физических показателей, а также результатов профессионального психологического отбора. Среди курсантов первого курса встречаемость ретроцеребеллярных кист составила 8,2%. У летчиков с опытом выявлена высокая частота бессимптомных ретроцеребеллярных кист (в двух случаях из пяти). Сравнение показателей между группами позволяет сделать выводы о возможном незначительном влиянии данных изменений на годность к летной работе. Дальнейшие исследования необходимы для уточнения механизмов влияния ретроцеребеллярных кист на летную деятельность и разработки соответствующих рекомендаций для медицинских комиссий.

Ключевые слова: военно-врачебная экспертиза, ликворная система, нейровизуализация, курсанты, летчики

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Соблюдение этических стандартов: клиническое исследование проведено в соответствии с принципами Хельсинкской декларации.

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In 2022, the Decree of the Government of the Russian Federation No. 565 “About approval of the Regulations on military-medical examination” dated 04.07.2013 was amended [1]. According to the document, brain MRI during the medical flight expert commission (VLEK) has first become mandatory for the citizens studying at the military educational institutions responsible for training of flight personnel of the state aircraft.

The analysis of the air force cadets’ first quantitative brain MRI results revealed high prevalence of various cerebrospinal fluid system alterations [2] representing the criterion for being unfit for flight training based on VLEK [1]. The data on the prevalence of alterations in the cerebrospinal fluid system of the brain among cadets were acquired during the study. That is why VLEK was given a task to determine the cadet’s category of fitness for further flight training.

All the non-neoplastic abnormalities and/or variants of the central nervous system (CNS) development showing no clinical manifestations or functional impairment represent the criterion of unfitness for flying duties used when conducting VLEK, regardless of the type of aircraft [1].

The study was aimed to assess the impact of retrocerebellar cysts in the brain on the pilot’s performance based on the comparative analysis of the brain MRI data of first-year air force cadets and air force pilots, who had successfully finished their flight duties.

METHODS

We used brain MRI data to assess the prevalence of retrocerebellar cysts among 348 (100%) first-year cadets studying at the Krasnodar Higher Military Aviation School of Pilots named after Hero of the Soviet Union A.K. Serov (median age was 19.0 years) during their first VLEK conducted at the 419th Military Hospital

(Krasnodar) between October 2022 and February 2023. Inclusion criteria: the first-year cadets admitted to the aviation school in 2022–2023 were included in the study. During the period when the cadets underwent MRI (October 2022 to February 2023), MRI was also performed in the retired air force pilots having no neurological complaints, who contacted the 419th Military Hospital for outpatient care. We compared retrocerebellar cysts of the cadets and five military pilots in the reserve (median age 42.8 years), who had successfully finished their flight duties and undergone brain MRI. The clinical trial was conducted in accordance with the principles of the Declaration of Helsinki.

Brain structures were assessed using the open MRI-AMICO300 scanner (AMICO; Russia) with the induction of 0.3 T. The standard brain MRI protocol was used [3]. All the acquired MRI scans (100%) were processed using the Machaon DICOM software tool.

Academic performance was assessed in accordance with the qualification requirements for professional military training of graduates.

Individual assessment of the cadets’ physical fitness was performed in accordance with the thematic plan of the Department of Physical Training of the aviation school. The following parameters of physical development were distinguished: speed (100 m race), strength (pull-ups), endurance (1 or 3 km race), and agility (shuttle run 10 × 10 m).

The results of professional psychological selection (PPS) conducted at admission to the military school were used to estimate the cadets’ professionally significant personality and intellectual qualities [4].

All the first-year cadets ($n = 348$) underwent brain MRI, no contrast agent was administered [3]. After selection,

100% of the cadets included in the study were divided into two groups based on the presence or absence of brain alterations in MRI. The group of patients having structural brain alterations consisted of 41 individuals; all the alterations found in the imaging region were assessed in order to find the most representative element that would be later defined as the object of research by the authors (retrocerebellar cysts found in 28 cadets).

Two groups of cadets were compared based on the following:

- estimates obtained when entering the aviation school and during the period of professional development (main academic disciplines and physical training);

- categories of professional psychological selection assigned when entering the aviation school;

- “Adaptability” multilevel personality questionnaire designed to study adaptive capacity based on the assessment of certain psychophysiological and socio-psychological characteristics reflecting the integral features of the cadet’s mental and social development.

The non-contrast-enhanced brain MRI was also performed in five patients in the group of individuals in the reserve, among them two patients underwent assessment in other medical institutions. The remoteness of assessment did not exceed two weeks from the date of assessing the main population.

RESULTS

The diagnostic tests performed as part of VLEK in 348 first-year cadets showed that the most prevalent cerebrospinal fluid system alterations were as follows: retrocerebellar cysts — 28 (8.2%), enlarged cerebrospinal fluid spaces — 3 (0.9%), asymmetry of the lateral ventricles — 3 (0.9%), septum pellucidum cyst — 3 (0.9%), internal hydrocephalus — 2 (0.6%), and temporal arachnoid cysts — 2 (0.6%). In the total sample of cadets, retrocerebellar cysts were found in 28 cases, the average cyst size was 9.5 mm (Fig. 1).

At the same time, the routine examination of five military pilots in the reserve included in the total sample revealed retrocerebellar cysts in two cases, the average cyst size was 8.1 mm. Thus, an asymptomatic retrocerebellar cyst sized 9 × 11 mm was found in patient S. aged 42 years (total flight experience exceeding 1500 h, including 800 h on the Su-24 fighter) (Fig. 2).

Comparison with the PPS data obtained at admission to the aviation school (Table 1), academic performance scores for the main disciplines and physical performance obtained throughout the entire training period (Table 2) was conducted in order to assess the CNS functional state in the cadets showing no MRI alterations (group 1) and cadets showing MRI alterations (retrocerebellar cysts) (group 2).

Pilots of group 1 were assigned PPS category 1 in 2% of cases, category 2 in 89% of cases, and category 3 in 9% of cases. Pilots of group 2 were assigned PPS category 2 in 100% of cases, which suggested functional adaptability of the cadets of group 2 (Table 1).

The average scores for the main disciplines and physical training showed no significant differences between two groups of pilots (Table 2).

The reasons for the first-year cadets’ expulsion from the higher aviation school were assessed in both groups in order to compare the cadets’ success (Table 3).

There were 4 cadets (10%) discharged for health reasons (due to retrocerebellar cysts) after VLEK. Twice more first-year cadets of group 2 (with retrocerebellar cysts in MRI) resigned

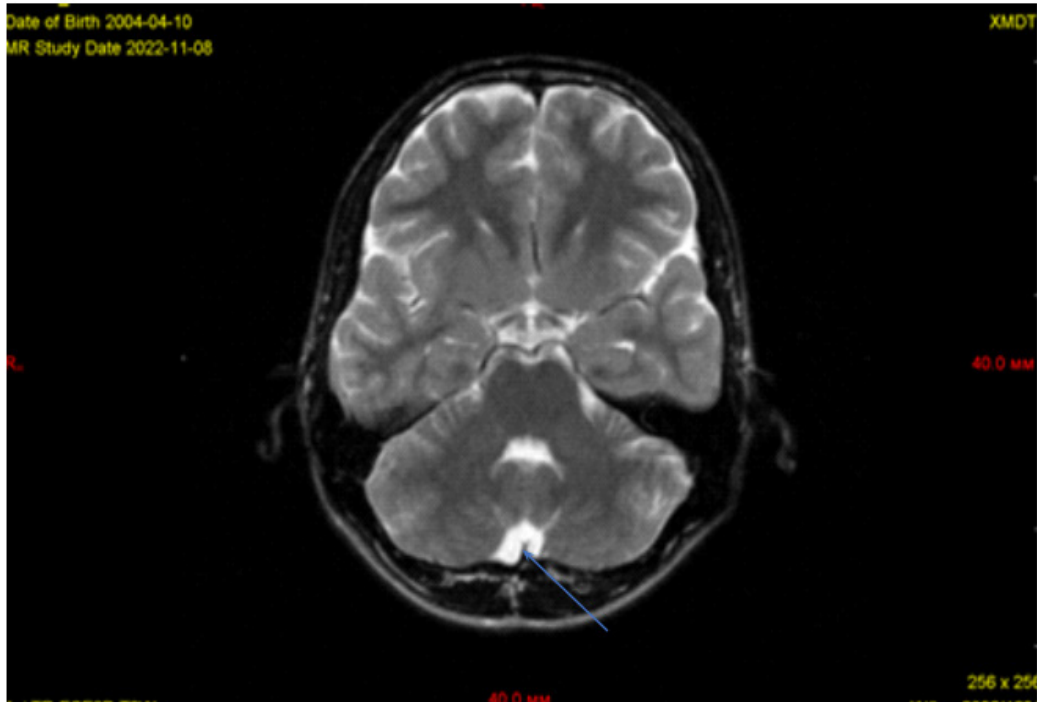


Fig. 1. T2-weighted MRI, axial slice: arachnoid spaces at the level of the cerebellar hemispheres (retrocerebellar cyst) in the form of local enlargement with the axial size up to 7×11 mm in the first-year cadet H. aged 20 years. This cadet, Candidate for Master of Sport in swimming, prize-winner of the Cup of the Russian Armed Forces among cadets, was recognized as unfit for flight training [1]

due to personal reasons after MRI compared to cadets showing no MRI alterations (Table 3). This was due to high psychoemotional stress and concerns for further flight career among cadets of group 2, who had undergone brain MRI.

DISCUSSION

The data on the CNS functional state (brain MRI) and personal adaptive capacity assessed during the study showed that 100% of surveyed cadets had good performance and showed

no significant differences, which suggests overestimation of the impact of retrocerebellar cysts on the category of fitness for flight duties [5].

The data provided are in line with the data of the other study [6] showing excessive demands on the presence of retrocerebellar cysts and no need for mandatory dismissal from flight duties based on VLEK.

The available literature provides wide coverage of the results [7] suggesting that the size and localization of masses in the retrocerebellar region (retrocerebellar cysts) have no

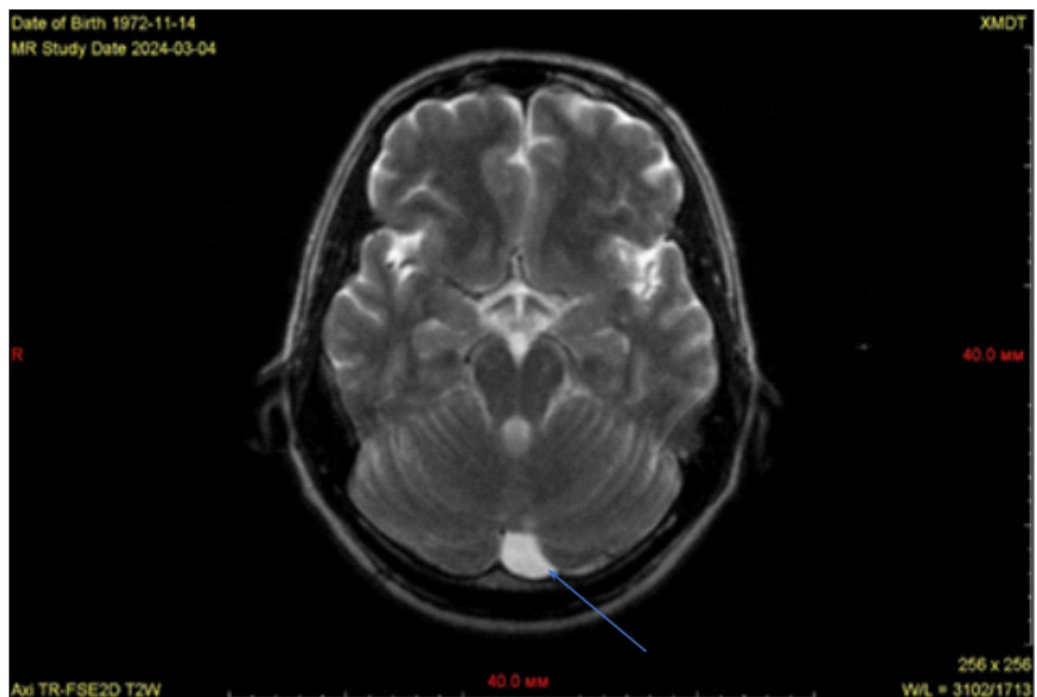


Fig. 2. Arachnoid retrocerebellar cysts in the military pilot in reserve S. This officer was discharged from military service due to reaching the maximum age limit. Brain MRI was not performed during previous VLEKs, the pilot was considered to be fit for flight duties

Table 1. Results of the professional psychological selection of the cadets of groups 1 (no brain alterations in MRI) and 2 (retrocerebellar cysts in MRI)

Category of professional psychological selection conducted at admission to the aviation school	Group 1, <i>n</i> = 307 (100%)	Group 2, <i>n</i> = 28 (100%)
1	8 (2%)	0 (0%)
2	268 (89%)	28 (100%)
3	31 (9%)	0 (0%)
4	0 (0%)	0 (0%)

Table 2. Average scores for the main academic disciplines and physical training in cadets of groups 1 (no brain alterations in MRI) and 2 (retrocerebellar cysts in MRI)

Academic performance	Group 1, no alterations based on MRI data (<i>n</i> ~307)	Group 2, alterations based on MRI and CT data (<i>n</i> ~28)
Average score for exams, 2 nd semester, 1 st year (2022–2023)	(<i>n</i> ~307) 4.2 ± 0.3	(<i>n</i> ~28) 4.1 ± 0.5
Average score for exams, 1 st semester, 2 nd year (2023–2024)	(<i>n</i> ~288) 251.0 ± 21.0	(<i>n</i> ~19) 248.0 ± 25.0
Average score for physical training, 2 nd semester, 1 st year (2022–2023)	(<i>n</i> ~307) 263.0 ± 22.0	(<i>n</i> ~28) 260.0 ± 26.0
Average score for physical training, 1 st semester, 2 nd year (2023–2024)	(<i>n</i> ~288) 4.3 ± 0.5	(<i>n</i> ~19) 4.2 ± 0.6

Table 3. Structure of reasons for expulsion from the aviation school in the first year among cadets of groups 1 (no brain alterations in MRI) and 2 (retrocerebellar cysts in MRI)

Reason for expulsion	Number of individuals expelled during their first year, no alterations in MRI Group 1 100% (<i>n</i> ~307)	Number of individuals expelled during their first year, alterations in MRI Group 2 100% (<i>n</i> ~28)
Poor academic performance	4 (1.3%)	1 (2.4%)
Indiscipline	4 (1.3%)	1 (2.4%)
VLEK results	0 (0%)	4 (10%)
Personal reasons	10 (3.3%)	3 (7.3%)

significant effect on the cerebrospinal fluid dynamics, and their clinical significance is poorly understood, which is in line with the data provided.

It should be noted that the presence of accidentally discovered cysts in two pilots in the reserve having a decent history of service, long flight experience on various types of aircraft and discharged from military service not for health reasons confirms the hypothesis about the negligible impact of retrocerebellar cysts found in pilots on their performance and professional longevity.

CONCLUSIONS

The findings undoubtedly require further research. However, the patterns revealed raise additional issues related to prediction of the impact of retrocerebellar cysts on the pilot's category of fitness determined during VLEK.

It is necessary to continue the research in order to gain the body of evidence and provide the possibility to predict the effects of retrocerebellar cyst in the brain on the cadets' performance and professional longevity.

References

1. Postanovlenie Pravitel'stva RF ot 04.07.2013 № 565 (red. ot 03.02.2023) «Ob utverzhdenii Polozheniya o voenno-vrachebnoy ekspertize». Russian.
2. Kolomiitsev VG, Gornov SV, Gornov VV, et al. Functional assessment of MRT and EEG results of the brain of young pilots in the interests of medical-flight examination. Bulletin of the Medical Institute of Continuing Education. 2023; 3 (3): 91–5. Russian.
3. Pronin IN, Zakharova NE, Batalov AI, et al. Diagnostic standards in diagnostics of brain disorders. Kremlin medicine journal. 2020; 1 (4): 107–18. Russian.
4. Priказ Ministra oborony Rossiyskoy Federatsii ot 31.10.2019 № 640 «Ob utverzhdenii Instruksii ob organizatsii i provedenii professional'nogo psikhologicheskogo otbora v Vooruzhennykh Silakh Rossiyskoy Federatsii». Russian.
5. Blagin AA, Churanov AM, Churanova TY. The concept of «success in training cadets» of a military educational institution. Voennyi akademicheskii zhurnal. 2022; 4 (36): 28–35. Russian.
6. Vlasov VV. The concept of risk factors and flight certificate examination. Aviakosmicheskaya i Ekologicheskaya Meditsina. 1995; 29 (5): 4–9. Russian.
7. Likhachev SA, Astapenko AV, Korbut TV, Antonenko SA, Gvishch TG, Merkul OV. Arakhnoidal'naya kista — sluchaynaya nakhodka. Nevrologiya i neyrokhirurgiya. Vostochnaya Evropa. 2014; 1 (21): 157. Russian.

Литература

1. Постановление Правительства РФ от 04.07.2013 № 565 (ред. от 03.02.2023) «Об утверждении Положения о военно-врачебной экспертизе».
2. Коломийцев В. Г., Горнов С. В., Горнов В. В. и др. Функциональная оценка результатов МРТ и ЭЭГ головного мозга молодых летчиков в интересах врачебно-лётной

- экспертизы. Вестник Медицинского института непрерывного образования. 2023; 3 (3): 91–5.
3. Пронин И. Н., Захарова Н. Е., Баталов А. И. и др. К вопросу о стандартах диагностики поражений головного мозга. Кремлевская медицина. Клинический вестник. 2020; 1 (4): 107–18.
 4. Приказ Министра обороны Российской Федерации от 31.10.2019 № 640 «Об утверждении Инструкции об организации и проведении профессионального психологического отбора в Вооруженных Силах Российской Федерации».
 5. Благинин А. А., Чуранов А. М., Чуранова Т. Ю. Успешность обучения курсантов военно-учебного заведения. Военный академический журнал. 2022; 4 (36): 28–35.
 6. Власов В. В. Концепция факторов риска и врачебно-летная экспертиза. Авиационная и экологическая медицина. 1995; 29 (5): 4–9.
 7. Лихачев С. А., Астапенко А. В., Корбут Т. В., Антоненко С. А., Гвиц Т. Г., Меркуль О. В. Арахноидальная киста — случайная находка. Неврология и нейрохирургия. Восточная Европа. 2014; 1 (21): 157.