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VESTIBULAR LOADING TESTS OF CANDIDATES FOR SPACE FLIGHT

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Space flight exerts particular influence on the whole organism. Exposure to increased acceleration and weightlessness is accompanied by serious vestibular disorders. These symptoms often decrease performance of cosmonauts in a troublesome extent [2, 7, 10].

According to other studies vestibular discomfort symptoms can be noticed after space flight, during the time of readaptation [1]. So it is not accidental that - from the very beginning of space flight - attention is being paid to vestibular resistance study of candidates for space flight [7].

Hilov pointed out that in selection of candidates for space flight we need persons with excellent vestibular resistance. Gaining these experiences, such kinds of methods are adopted, which bring about extreme loading level of the vestibular system. In medical examinations different kinds of vestibular system's loading were used. On the basis of arising vegetative symptoms, caused by loading, an evaluation method was employed to form countenance opinion [3, 4, 5, 8].

METHOD

In our medical examination 27 supersonic pilots took part. They were 25-39 years old. In selection candidates we used the vestibular loading test, suggested by Markarjan and his coworkers [9].

In the test of Coriolis acceleration's cumulative effect by continuous stimulation /CA by CS/, the tested person sits in a rotation chair /Bárány/, his body and head position agrees with the axle of rotation. The chair is rotating at a speed of 180°/sec, so one total rotation is done in 2 seconds. After the 5th rotation /in the 10th sec/ the tested person begins head bending from one shoulder to the other. The minimal degree of head bending is 30°. The head bending is done continuously, without unnecessary cervical-muscle tension and without head rotation. The candidates for space flight did this kind of vestibular loading test for 10 minutes.

The other loading test was the test of Coriolis acceleration's cumulative effect by periodical stimulation /CA by PS/. The tested person sits in a rotation chair with closed eyes, and he bends his body and head with 90°, compared to the rotation axis. The chair is rotated continuously and steadily /1 rotation 2 sec/ at a speed of 180°/sec. After the fifth rotation the patient straightens out for a command. Every erection and bending forward happen for 3 sec. The erection and bending forward are done rhythmically by 5 seconds for a command. The test is carried out for 1 minute in one direction, and it is followed by 1 minute break. After this we continue rotation - for 1 minute again - but in the other, opposite direction. The Coriolis acceleration's cumulative effect by continuous stimulation /CA by CS/ was done for ten minutes, and the periodical stimulation of the Coriolis acceleration's cumulative effect was done 5 times by 1 minute right and left side rotation.

To evaluate vestibular tolerance on the basis of vegetative reactions, we used a point-evaluation method. This method was compiled from the literature.

We registered the parameters by a Medicor KTD device during vestibular loading and in recovery period to estimate the haemodynamic changes caused by vestibular loading. We registered the changes of systolic and diastolic blood pressure and of pulse rate. During the time of vestibular loading, the ECG in 1 lead was registered by Avionics recorder.

A stabilometric investigation was performed by ISSI Stabilometer device before and after the vestibular loading, to evaluate oculo-vestibulo-proprioceptive coordination. We examined standing stableness for 30 sec, and tested the number of corrective motion during this time. We examined standing stableness for 30 sec, and measured the number of corrective motions /IMP/ during this time, and the time used for it /SEC/. We derived a parameter from these which showed the required mean time to motion correction, in msec $/\frac{SEC}{IMP}/$. According to our earlier tests, corrective time is very characteristic of psychomotor function [6]. Corrective time of quick motion organization is under 200 msec, while corrective time of slow motion is above 250 msec.

RESULTS

In Table 1 vestibular tolerance is evaluated by a point system.

Table 1

Evaluation of the vestibular tolerance

Points	Reaction	
0 1 2 3	No reaction Flush Getting pale Getting pale, perspiring /in a slight degree/	Good
4 5	Getting pale, perspiring /to a greater extent/ Getting pale, perspiring /to a greater extent/ Perioral automatism	Acceptable
6 7	Nausea Vomiting, medical examination interrupted	Bad

Persons with good tolerance did not show any reaction, or showed only slight paleness or perspiring. Persons with acceptable tolerance showed an increased degree of paleness, perspiring or perioral automatism. Persons with bad tolerance had nausea, vomiting, so medical examination was interrupted.

Table 2

Points of 27 astronaut candidates' vestibular sensibility

	CA by CS	CA by PS	ALL
1. F.B.	3	3	6
2. M.B.	3	3	6
3. E.L.	0	0	0
4. B.I.	2	2	4
5. G.P.	0	0	0
6. W.E.	3	2	5
7. N. Gy.	3	3	6
			3.86±2.73
8. P.Z.	3	3	6
9. T.I.	0	0	0
10. G.O.	0	3	3
11. L.Gy.	2	4	6
12. V.J	3	4	7
13. C.Gy.	3	3	6
14. P.J.	0	2	2
15. M.M.	3	3	6
16. M.Gy.	0	2	2
GOOD TOLERANCE			4.06±2.52
17. G.P.	4	3	7
18. G.Gy.	4	4	8
19. L.I.	4	4	8
20. B.F.	4	3	7
21. H.K.	5	4	9
22. M.J.	4	5	9
ACCEPTABLE TOLERANCE			8.0±0.89
23. P.S.	3	7	10
24. V.L.	3	6	9
25. F.Gy.	4	6	10
26. H.L.	6	7	13
27. H.T.	7	6	13
BAD TOLERANCE			11.0±1.87

CA by CS / Coriolis acceleration by continuous stimulation
CA by PS / Coriolis acceleration by periodical stimulation

In the upper part of Table 2 those candidates are displayed, who were found suitable in every respect. Their data were registered during Coriolis acceleration by continuous stimulation /CA by CS/ and during periodical stimulation /CA by PS/. The means of this group are the best, and differ from the other groups. According to our experience, those persons must be disqualified, who score more than 6 points during 2 loadings. According to our system the mean of persons with good tolerance was 4.00 $\pm$ 2.50 points. By the whole medical test, our two candidates for space flight belonged to the group of persons with good tolerance. Their mean was 3.9. During the selection time our two candidates for space flight did not belong to the group of persons with good tolerance.

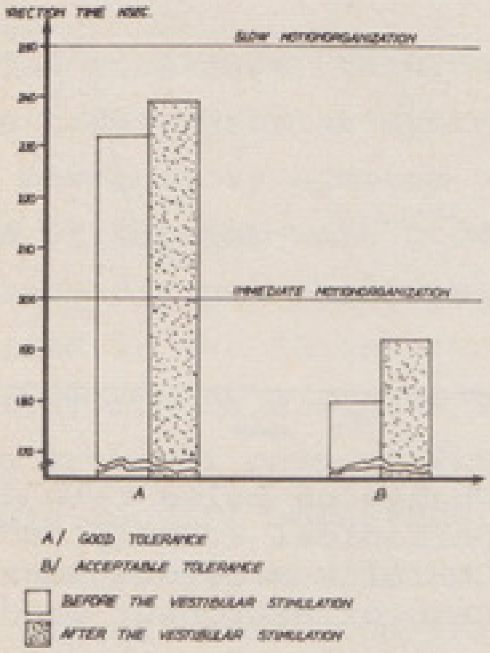

Fig. 1. The date of stabilometry

It can be seen that persons with acceptable tolerance belonged into the group with quick motion correction.

With the help of ECG device we determined the pulse rate, the change in PQ distance and stableness of RR distance /Fig. 2/.

Figure 3 shows the change in pulse rate during continuous stimulation of Coriolis acceleration /CA by CS/, and Figure 4 during periodical stimulation of Coriolis acceleration /CA by PS/. We have stated that the pulse rate of persons with good tolerance is higher. The pulse rate of persons with bad tolerance is lower, or it shows unstableness.

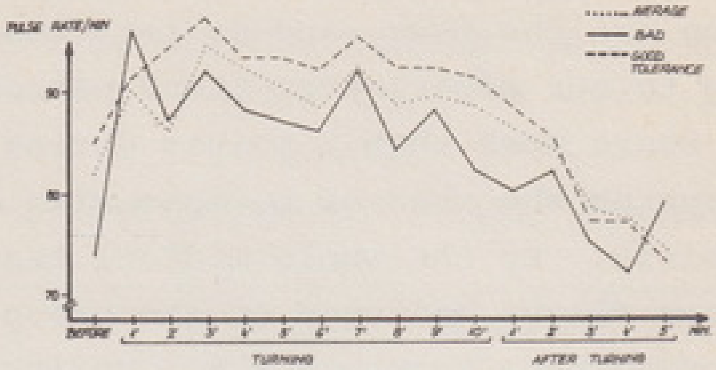

Fig. 2. Change of pulse rate during continuous stimulation of the Coriolis acceleration /in the case of astronaut candidates/

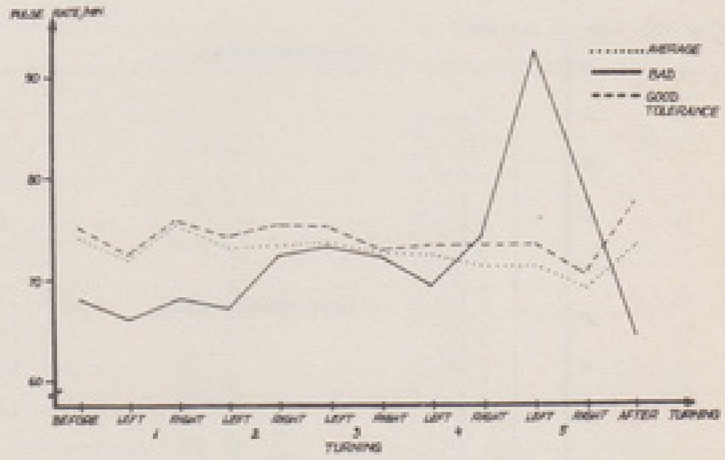

Fig. 3. Change of pulse rate during periodical stimulation of the Coriolis acceleration /in the case of astronaut candidates/

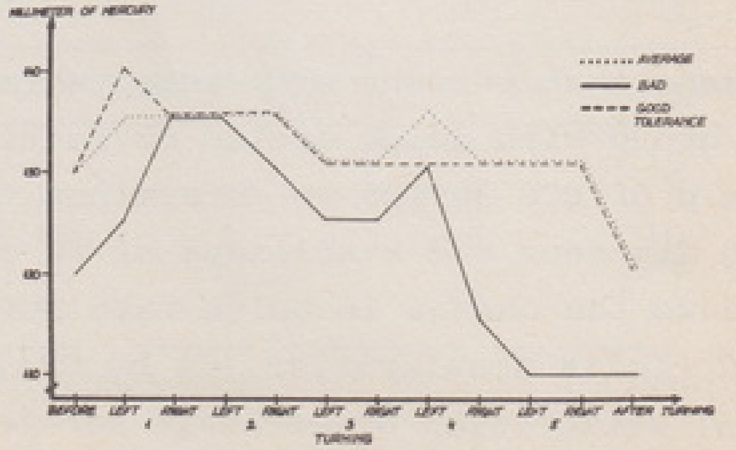

Fig 4. Systolic pressure during periodical stimulation of the Coriolis acceleration

Figure 5 shows the change of systolic blood pressure, during continuous stimulation of Coriolis acceleration. Hypotonic tendency can be noticed in persons with bad tolerance.

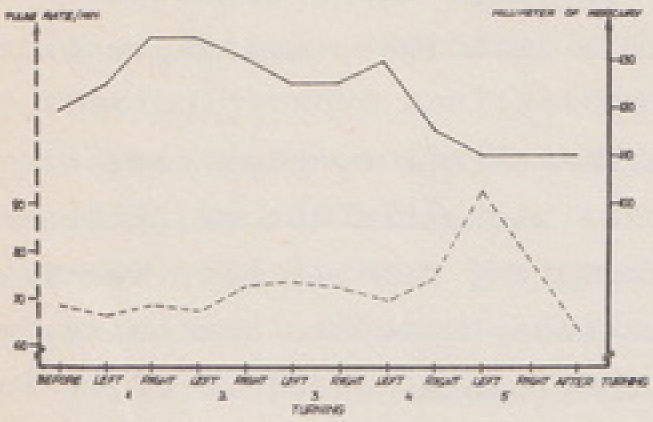

Fig. 5 Change of systolic pressure
and pulse rate in the case of
bad tolerance /5 men/

In persons with bad tolerance, tachycardia and hypotension show the change of the cardiovascular system's unsteadiness. This is a threatening premonitory symptom of circulatory failure. The RR intervals of persons with good tolerance were stable, their PQ distance did not change significantly. Unsteadiness can be noticed in the RR interval during the time of vegetative indisposition, and PQ distance increases from 0.16 sec to 0.20 sec in the group of persons with bad tolerance. Bertalan Farkas and Béla Magyari bore vestibular load with high pulse- and blood-pressure rate compared to the average; the haemodynamic features proved their good tolerance. Their ECG RR intervals were stable, and PQ distance was constant.

SUMMARY

There are very important vestibular loading medical assays in selection of candidates for space flight. But it is not satisfactory to evaluate these tests by subjective vegetative symptoms. The more objective estimation of vestibular tolerance is enabled by combining the examinations with simultaneous measuring of different haemodynamical samples.

We have stated that the water-hammer pulses of persons with good tolerance were accompanied with stable blood pressure value, and we did not notice any deviation in the bioelectric function of the heart. Persons with bad tolerance have low pulse rate, they are susceptible to hypotension, and some unstableness appears in their nerve conduction. Hypotonic condition with tachycardia is a threatening premonitory symptom of circulatory failure.

The justification of our complex test was confirmed, because Bertalan Farkas withstand the weightlessness well, he preserved his performance, did not have vestibular discomfort feeling during the readaptation to the earthy gravitation and had no vestibular complaints.

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