Clinical Studies

PROPRIOCEPTIVE CORRECTION OF THE VERTICAL POSITION IN PATIENTS WITH INFANTILE CEREBRAL PARALYSIS (РЕГУЛЯЦИЯ ВЕРТИКАЛЬНОЙ ПОЗЫ У БОЛЬНЫХ ДЕТСКИМ ЦЕРЕБРАЛЬНЫМ ПАРАЛИЧОМ ПРИ ЛЕЧЕНИИ МЕТОДОМ ПРОПРИОЦЕПТИВНОЙ КОРРЕКЦИИ)

S. A. Nemkova, V. I. Kobrin, * E. G. Sologubov, A. B. Yavorsky, A. N. Sinelnikova

Children's Psychoneurological Hospital No 18 (Moscow), *Russian State Medical University (Moscow)

We studied the ability of healthy youngsters and patients with infantile cerebral paralysis to maintain a vertical position when wearing a treatment Adeli Suit (a modification of a Penguin suit used by astronauts to prevent unfavorable effects of weightlessness on human skeleton and muscles during prolonged space flights). Results of comparative stabiographic examination made during application of the dynamic proprioceptive correction method indicate that people with opposite sex differ in terms of stability and role of the visual analyzer in maintenance of their vertical position.

Introduction

Maintaining vertical position in people is the result of interconnection of human sensor and neuromuscular systems. Precise accommodation to constantly changing conditions is insured by human's multi-level regulation system [1, 2]. When a human stands straight his centre of gravity (CG) is constantly vibrate in front and sagittal planes that occur though breathing, work of heart and circulation of blood. The most important in this process is the functional state of the nervous system [1, 2, 4]. Available literature on the subject does not provide enough information on special features of regulation of position neither in healthy people of different sex nor in patients with disturbances of their vertical position. Patients with infantile cerebral paralysis (ICP) practically always demonstrate reduction in the stability of their erect position and lower role of the visual analyzer in the control of this position [5, 6]. We believe that the study of ability of patients of different sex with ICP to maintain vertical position as well as the study of the role visual analyzer in the maintenance of their vertical position prior and after treatment with a new method of dynamic proprioceptive correction (DPC) might has an important theoretical and practical significance.

Experimental procedure

The study was made with 4 groups of youngsters (healthy ones and those suffering from ICP) ranging in years from 13 to 16 years. Each of the groups was divided into two subgroups - boys and girls (Table 1).

Table 1. Distribution of test subjects

Groups	Number	
	Boys	Girls
Healthy	6	6
Patients with spastic diplegia	14	18
Patients with hemiparetic form of ICP	21	11
Patients with hyperkinetic form of ICP	12	15

The study was made with the use of a computer stabilograph as the Romberg' test on the stabilographic platform [5, 6].

A statokinesigram is a projection of the CG shift onto the horizontal plane. We analyzed the area of statokinesigram that is actually an amplitude of vibrations of the CG, and the more the area the lower is the stability of test subjects [5,6]. In order to estimate the role of the visual analyzer in maintaining vertical position we determined the ratio of the statokinesigram area to one and the same parameter with and without visual control (S/So).

In healthy people this ratio is more than one unit since in the standing position with visual control the statokinesigram area is smaller than without the one [5, 6]. Decrease of this ratio indicates a drop in the role of the visual analyzer, and increase – a rise of the role of visual analyzer in regulation of vertical position [5, 6].

Stabilographic examination of healthy youngsters was made before application of method called dynamic propreoceptive correction (DPC), i.e. before wearing a special Adeli Suit which provides a dynamic proprioceptive correction (hereinafter – DPCS = dynamic proprioceptive correction suit) [5, 6]. The Adeli Suit is a modification of the Penguin suit used to prevent adverse effects of weightlessness on human muscles and skeleton during prolonged space flights.

Stabilographic examination of patients was made before, during and after a single load got from DPCS as well as after a course of treatment with DPCS. The treatment course consisted in 20 sessions of wearing the DPCS with a gradual increase of staying in the suit from 15 min to 1 hour per day.

For the statistical treatment of data the nonparametric statistical method of Mann – Whitny was used.

Results and Discussion

Healthy youngsters. When analyzing initial stabilographic data no statistically significant differences in statokinesigram areas were found between boys and girls ($p > 0.05$). Without visual control, the area of statokinesigram increases ($p > 0.05$) in both groups (Fig.1) but more pronounced in girls (Table 2) indicating the importance of visual control in the vertical stability of healthy test subjects, especially in girls.

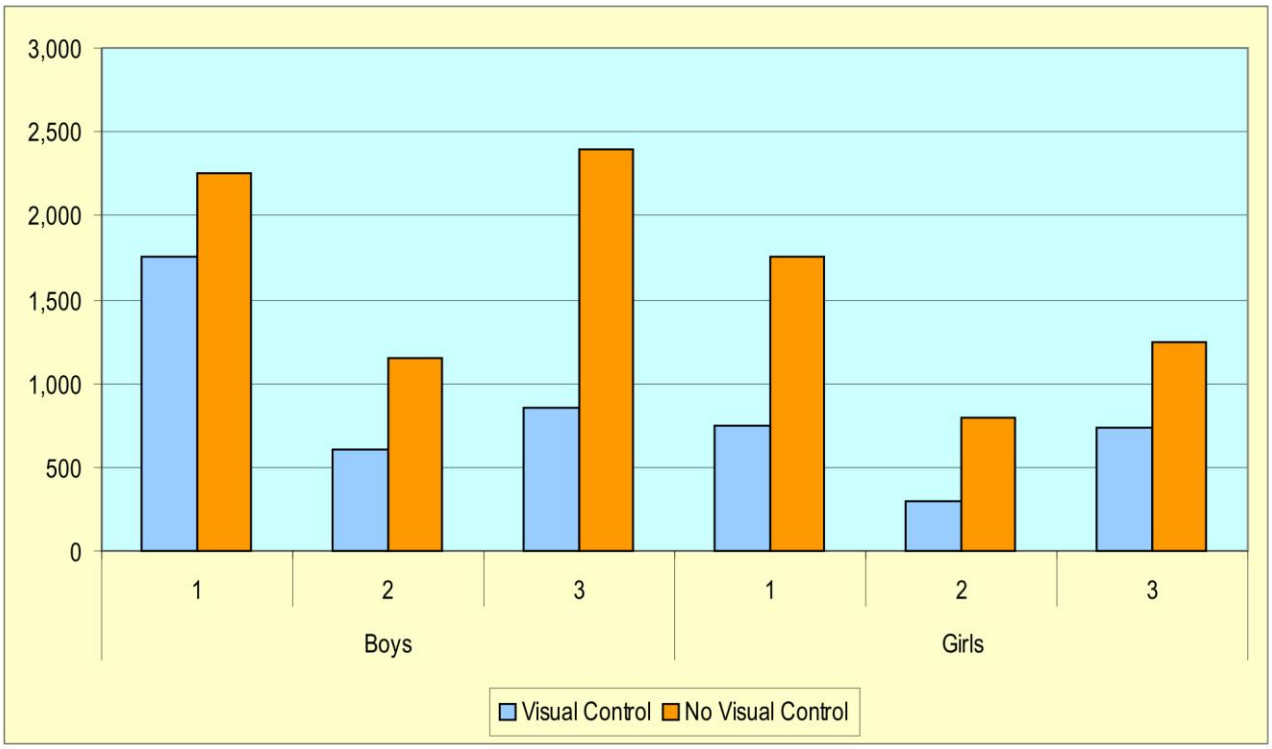


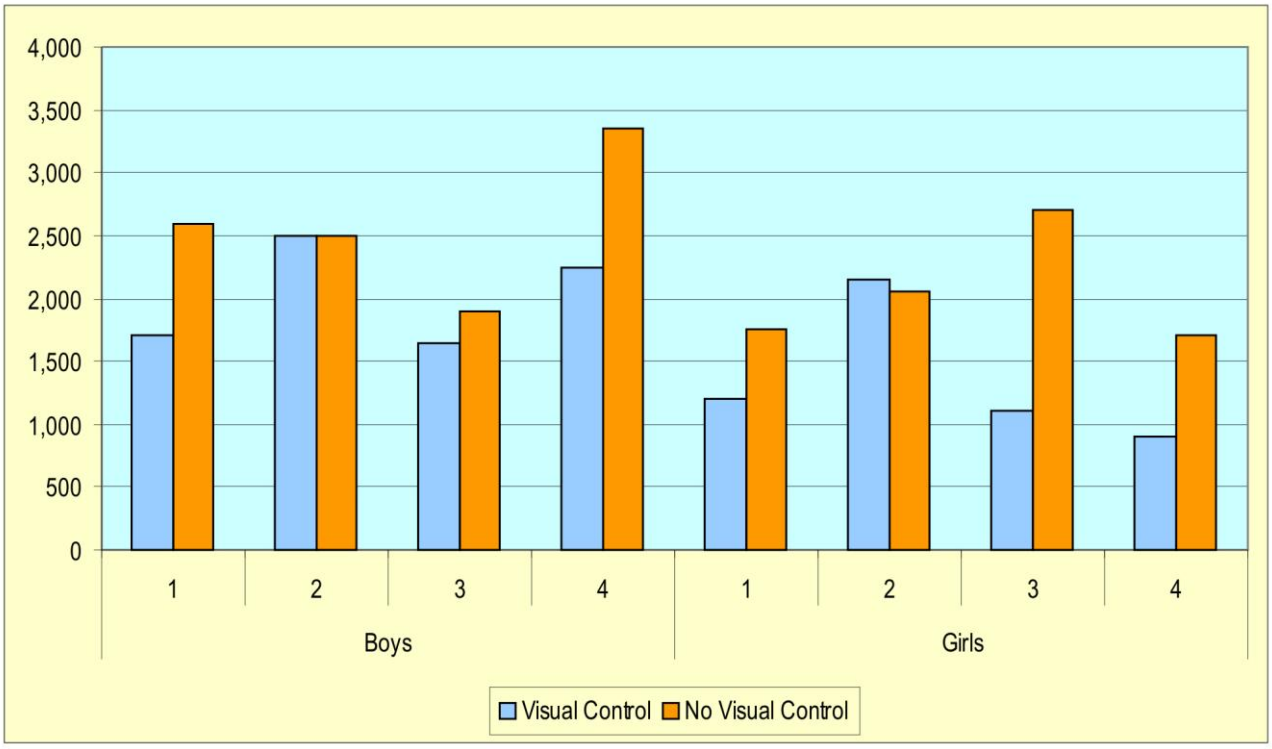
Fig.1. Mean values of statokinesigram areas in healthy youngsters during somatosensor stimulation using the method of dynamic proprioceptive correction. (**Designations: 1** – prior to wearing of the suit, **2** – with the suit on, **3** – after taking the suit off).

Healthy youngsters, both girls and boys, after a single use of the DPCS show a better stability and statistically significant differences for a standing position both with visual control and without it ($p < 0.05$) indicating the importance of the visual analyzer in controlling the vertical position not only before proprioceptive stimulation of people of both sexes but also during the stimulation process itself (Table 2).

Youngsters (males) after a single use of the DPCS demonstrate increase in ($p < 0.05$) in the stability of their position with the visual control, and decrease in it without such a control (Table 2).

Table 2. Mean values of ratios of statokinesigrams with and without visual control during somatosensoric stimulation (S/So)

S/So	Prior to DPCS		With DPSC		After DPSC		After DPCS Course	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Healthy	1.87 ± 0.21	2.34 ± 0.12	1.77 ± 0.06	2.14 ± 0.11	2.75 ± 0.18	1.63 ± 0.09		
SD	1.60 ± 0.11	1.48 ± 0.09	0.98 ± 0.05	0.76 ± 0.03	1.15 ± 0.08	2.42 ± 0.23	1.42 ± 0.11	1.90 ± 0.09
HP	1.62 ± 0.12	1.86 ± 0.09	1.92 ± 0.12	0.75 ± 0.01	2.06 ± 0.23	0.50 ± 0.01	1.49 ± 0.12	1.96 ± 0.05
HK	1.85 ± 0.13	1.32 ± 0.11	1.45 ± 0.12	1.96 ± 0.13	1.55 ± 0.16	1.83 ± 0.11	1.56 ± 0.12	1.89 ± 0.13



SD – Spastic diplegia, **HP** – Hemiparetic form, **HK** – Hyperkinetic form.

Fig. 2. Mean values of statokinesigram in patients with spastic form of ICP in somatosensor stimulation with dynamic proprioceptive correction. (**Designations: 1** – prior to wearing of the suit, **2** – with the suit on, **3** – after taking the suit off, **4** – after the treatment course).

In girls after single use of the DPCS the difference between the standing position with their eyes open or closed is less pronounces ($p > 0.05$) that prior to the use of the suit (Table 2). This indicates a reduction in the role of the visual analyzer in the control of the vertical position after proprioceptive load. Thus, our findings show that the visual analyzer in healthy youngsters is very stable and plays an important role in the regulation of the standing position, especially in girls. After a single use of DPCS the role of the visual analyzer in maintaining the vertical position increases in boys and decreases in girls.

Youngsters with spastic form of ICP. These patients demonstrate initial reduction (more pronounced in boys) of the standing position in comparison ($p < 0.05$) with healthy persons of the same age (Fig. 2).

Reduction of the role of the visual analyzer in the control of the body stability was not found to correlate with the sex of our test subjects (Table 2).

During the process of a single use of the DPCS we noted a reduction in the stability of the straight position in patients who were standing with visual control as well as the reduction of the role of visual system to regulate vertical position irrespective of the sex of patients (Fig.2, Table 2).

After a single use of the DPCS boys with spastic form of ICP show a better ($p < 0.05$) vertical stability without visual control (Fig.2) in comparison with initial data (Table 2) indicating a lower role of the visual analyzer in the regulation of the standing position.

Girls were not found to have statistically significant differences in the stability of their position right after a single use of the DPCS, however the role of the visual analyzer in the control of their vertical position goes up ($p < 0.05$).

After a course of treatment with the suit, boys increase their stability when standing with visual control ($p < 0.05$), and the role of their visual analyzer goes down. By contrast, girls improve (< 0.05) their vertical stability (Fig.2) with a smaller role of the visual analyzer in the regulation of a standing position (Table 2).

Youngsters with hyperkinetic form of ICP. These patients, whatever is the sex, have their original vertical stability already reduced ($p < 0.05$) (Fig.3); girls also show a smaller role of their visual analyzer in the regulation of vertical position (Table 2).

During the single-shot process of proprioceptive loading a reduction ($p < 0.05$) (in boys) and increase (in girls) (Fig.3) of stability was noted; this difference was shown to be statistically significant ($p < 0.05$). Also, boys show a reduction - , and girls an increase of the role of the visual analyzer in the control of their vertical position ($p < 0.05$) (Table 2).

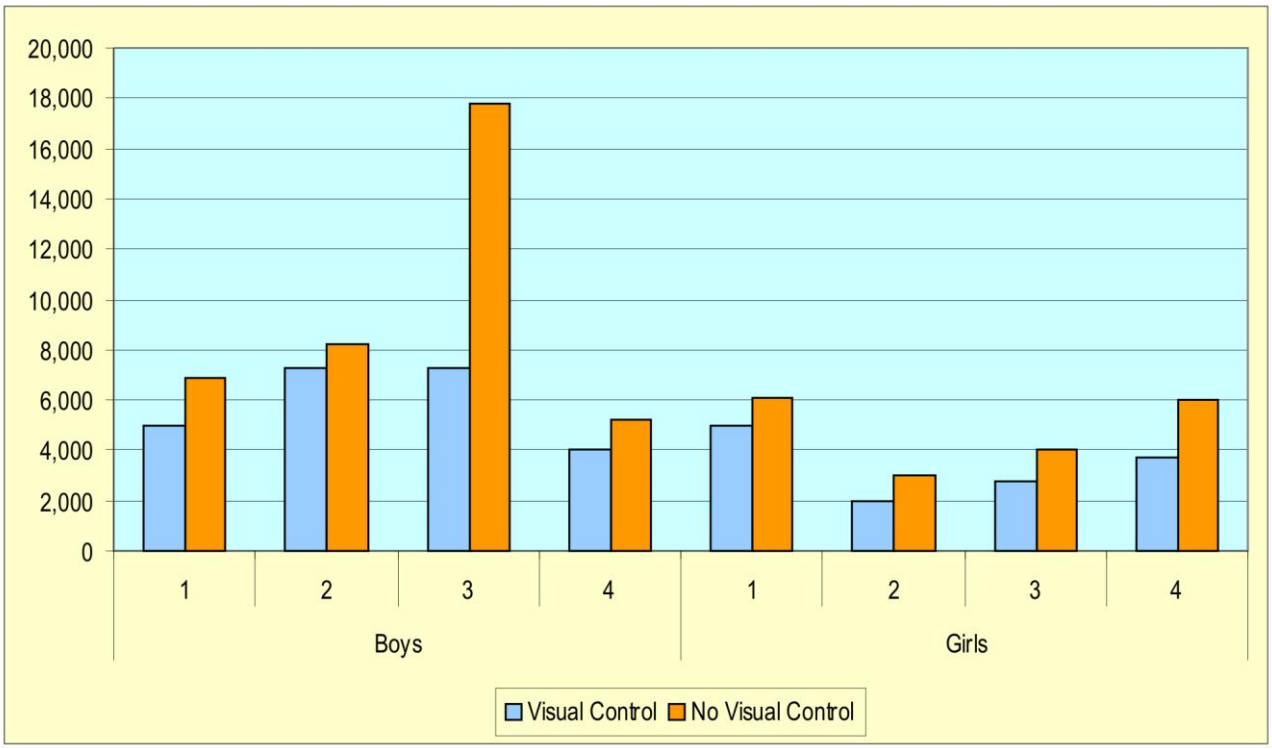


Fig. 3. Mean values of statokinesigram in patients with hyperkinetic form of ICP in somatosensor stimulation with dynamic proprioceptive correction. (**Designations: 1** – prior to wearing of the suit, **2** – with the suit on, **3** – after taking the suit off, **4** – after the treatment course).

Results got after the single use of the DPCS in comparison with initial data indicate that boys maintain a low - , and girls a high vertical stability (Fig. 3). The role of the visual analyzer in the control

of vertical positions remains reduced in boys, however, becomes increased in girls ($p < 0.05$) (Table 2).

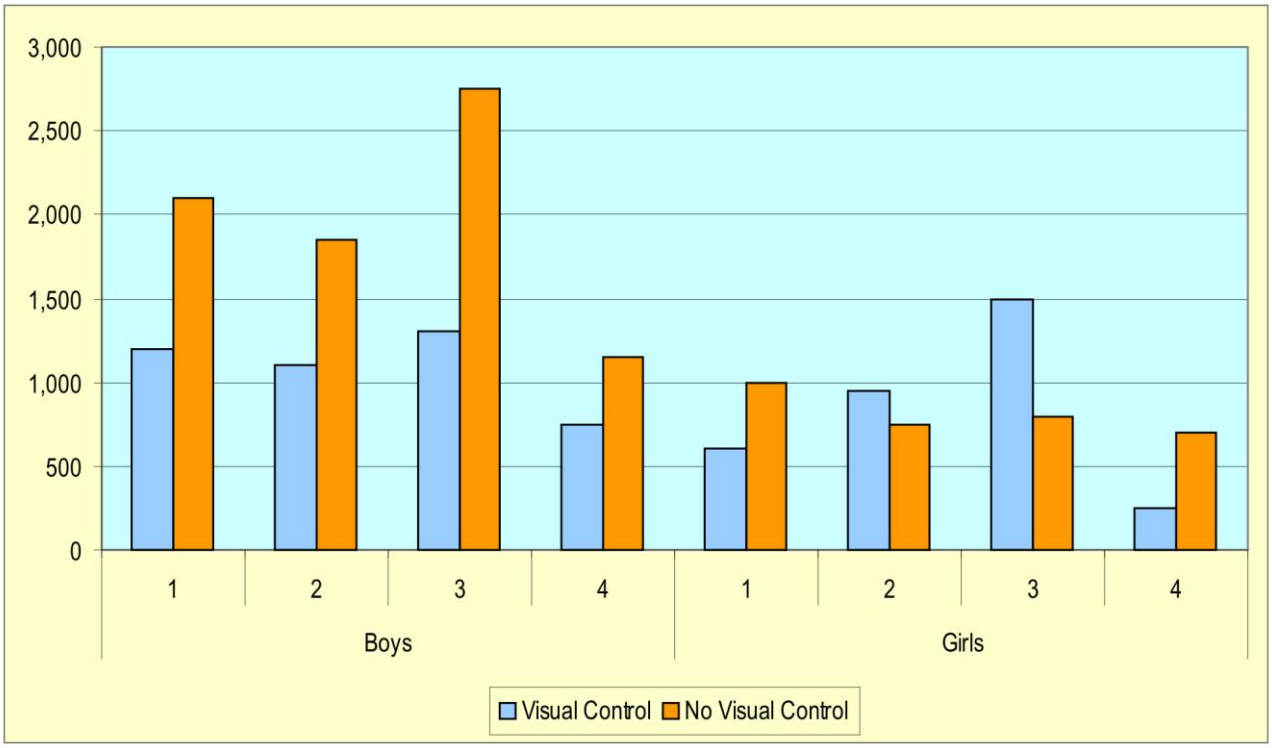


Fig. 4. Mean values of statokinesigram in patients with hemiparetic form of ICP in somatosensor stimulation with dynamic proprioceptive correction. (**Designations: 1** – prior to wearing of the suit, **2** – with the suit on, **3** – after taking the suit off, **4** – after the treatment course).

After the treatment course, girls increased ($p < 0.05$) their stability as compared with initial data when standing with visual control, and boys – when standing without visual control (Fig. 3). The role of the visual system in the standing position increases in girls and decreases in boys ($p < 0.05$) (Table 2).

Youngsters with hemiparetic form of ICP. Analyses of initial stabilographic data show that boys, as compared to girls, have lower stability and smaller role of the visual analyzer in regulation of their vertical position ($p < 0.05$).

During the single use of the DPCS no important changes in the boys' stability was observed (Fig.4); the role of their visual analyzer in the control of the standing position increases ($p < 0.05$). Girls showed a reduced role of their visual analyzer in the control of the standing position ($p < 0.05$).

After the single use of the DPCS we noted a reduction of stability in boys when they were standing with their eyes closed (Fig.4) and still quite an important role of the visual analyzer (Table 2). Girls showed a progressing reduction of their stability when they were standing with their eyes open ($p < 0.05$). All this indicates a decreased role of visual analyzer in the control of vertical position in patients with hemiparetic form of ICP (Table 2).

After a treatment course, the stability and role of the visual system in the maintenance of vertical position in girls do not significantly change as compared to initial data (Fig.4). Boys were found to have a better stability ($p < 0.05$) and smaller role of their visual analyzer (Table 2).

Thus, (prior to the use of the DPCS) statistically significant differences in the stability of boys and girls were found only in those suffering from a hemiparetic form of ICP. A single-shot affect of the suit changes the stability of patients with ICP in different ways: it smoothes away distinctions in the stability in males and females with a spastic form of the ICP; increases them in patents with

hemiparetic form, and increases the distinctions at the utmost in patient with a hyperkinetic form of ICP. Treatment with the new method also changes the initial stability of patients differently. In case of a spastic form of the disease: in boys the stability decreases with the visual control, in girls it increases without the one. In a hyperkinetic form: in boys the stability increases without visual control, in girls – with the one. In a hemiparetic form: the stability increases in boys not significantly changing in girls.

These distinctions seem to be associated with the change in the role of the visual system in regulation of the stability during the process of proprioceptive loading. The effect produced by the DPCS cause changes in the proprioceptive afferentation, one of important components which, along with visual inputs, provides information about the position of body in space and inter-location of its parts. We believe that basic mechanism of this effect should be attributed to the change in the interaction of visual and proprioceptive systems that takes place during the development of a new stereotype of posture (a so-called “sensor” conflict [3]) in our patients. This happens when associative zones of parietal lobes receive information about the structure of body and its positioning in space that differs from the one already accumulated by patients during their lives. As a result, there is a situation when the proprioceptive afferentation has changed and the visual one remains the same. Due to this the interconnection of visual and proprioceptive systems alter affecting the role of visual system in the control of the vertical stability. In addition, as our study show, interconnection of visual and proprioceptive analyzers are different for different sexes. After the treatment course using DPC, the role of the visual analyzer in boys with hemiparetic and spastic forms of ICP in the control of their vertical position was found to decrease as compared to the initial data. This role, however, does not change in patients with hyperkinetic forms of ICP. In girls with hyperkinetic and spastic forms of the disease the treatment course improved the role of the visual control having practically no effect on the one in girls with hemiparetic forms of ICP.

In conclusion, diverse effects the visual analyzer might produce on the stability of men an women during their proprioceptive correction should be taken into account in the treatment of patients with different form of ICP.

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