The Correlation Analysis of Clinic Data at Estimation of Motor Disturbances in Children with CP

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Abstract

This study aims to evaluate the relationship between motor functions in children with spastic cerebral palsy (CP). Fifty-three children with spastic CP participated in the study. The results of MRC, Modified Ashworth Scale (MAS), goniometry and Tardieu Scale were exanimate. The Pearson correlation coefficient was used to determinate the correlations. As a result, the data of every group tests are found to correlate with each other. These dependencies are visualized.

1 Introduction

The ICD 10 discriminate the cerebral palsy in children (CP) in the group of diseases of nervous system G80. Cerebral palsy (CP) is a group of persistent (but not necessarily unchanged), movement, posture, muscle tone, and motor skills disorders non-progressive, with early onset, due to non-progressive impairments, occurring on an immature brain or a brain under development (prenatal, perinatal, postnatal during the first 3-4 years of life) [1]. However, the etiology of CP is complex the main reason is brain disorders [1]. Therefore the nervous assistance has the main function in children with CP rehabilitation. Despite the fact that these dependencies are determined and proved statistically for some clinical cases [2-4], no attempts of its search in children with CP were undertaken.

Statistical analysis is one of the foundations of evidence-based clinical practice; the tool for clarification interaction of factors is its part the correlation analysis [5]. It is known as a widely used method in the analysis of clinic data in children with CP [6-8]. The authors in [6] have exanimated the distribution of spasticity types in CP groups by means of correlation analysis methods. In work [7], the correlation analysis helped to estimate the correlation between spasticity and pain in adults and adolescents with cerebral palsy. In work [8], correlation analysis is used to found the correlation between the therapeutic intensity of rehabilitation and functional improvement in children with cerebral palsy.

The aim of present work is to detect the correlations of clinic data at estimation of motor disturbances in children with CP (force changes, tone in lower limbs, motion in hip joint, knee-joint, ankle joint).

2 The data and methods

The data of work were the clinic data of estimation of MRC, goniometry (the determination of motion disorders in hip joint, knee joint, ankle joint) and hipertonia in lower limbs in children with the diagnosis: CP, spastic diplegia, GMFCS II. The sample contains 66 factors (table 1 contains the list of it) and 53 patients. The experts pointed out the target factors in every group. Table 2 shows the example of data.

Table 1: The factor list

The factor group of muscle tone (Ashworth scale)		The factor group of force estimation (MRC)		The factors group of goniometry and spasticity (Tardieu Scale)	
The name of factor	The description of factor	The name of factor	The description of factor	The name of factor	The description of factor
ash_L/R_B_O	The abductor of left/right hip tone	Target factor f_L/R_B_O	The force of abductor of left/right hip	R2-R1/ R2-R1.3	The difference in spasticity right/left hips R2 and R1
Target factor ash_L/R_B_P	The adductors of left/right tone	f_L/R_B_P	The force of adductors of left/right tone	Target factor R2-R1.1/R2-R1.4	The difference in spasticity right/left shin R2 and R1
ash_L/R_B_R	The tone of extension muscle of left/right hips	Target factor f_L/R_B_R	The force of extension muscle of left/right hips	Target factor R2-R1.2/R2-R1.5	The difference in spasticity right/left foot R2 and R1
ash_L/R_B_S	The tone of bending muscle of left/right hips	f_L/R_B_S	The force of bending muscle of left/right hips	G_L/R_GSS_TSr (target factor) G_L/R_GSS_TSs	The goniometry of extensors of left/right foot
ash_L/R_G_R	The tone of extension muscle of left/right shins	Target factor f_L/R_G_R	The force of extension muscle of left/right shins	G_L/R_KS_R/ G_L/R_KS_S	Extensor /bender left/right knee joint
Target factor ash_L/R_G_S	The tone of bending muscle of left/right shins	f_L/R_G_S	The force of bending muscle of left/right shins	G_L/R_TBS_O (target factor) / G_L/R_TBS_R/ G_L/R_TBS_S	Abductor/extender /reducer of left/right hip joint
ash_L/R_S_P	The muscle tone of left/right foot	f_L/R_S_P	The force of muscle of left/right foot	L/R_B_R1/ L/R_B_R2	The measure of adductors spasticity of R/L hip
Target factor ash_L/R_S_T	The tone of back bending of left/right foot	f_L/R_S_T	The force of back bending of left/right foot	L/R_G_R1/ L/R_G_R2	The measure of spasticity of bender muscle of R/L shin
				L/R_S_R1/ L/R_S_R2	The measure of spasticity of bender muscle of R/L foot

Table 2: The example of data

Patient number	f_R_B_S	f_R_B_R	f_R_B_P	f_R_B_O	R_G_R2	R_G_R1
1	4	4	4	4	145	120
2	5	4	5	4	130	120
3	4	5	5	4	130	105
4	4	4	4	4	150	150

Since the data are numeric, we can apply the Pearson sample correlation coefficient or Spearman rank correlation coefficient. Spearman rank correlation coefficient requires data with ranks. We have made attempt to rank data. After ranking the data according to the three ranks – norm, middle and low, obtained volumes of rank data are very different between each other. For instance, thanks to features characteristic in children in GMFCS II (MRC values limited by 4-5), almost all MRC data in children in GMFCS II belong to one rank (norm), however, the spasticity data have wide space with norm more than 140, middle – 140-130, low – lower 120. Therefore we consider applying the Pearson sample correlation coefficient.
All calculations have been performed in the framework Anaconda in Python.

2.1 Results and discussions

After deletion of incomplete data, the sample volume is 42 patients. We consider the clinic data of children before the first course of treatment.
We have estimated Pearson sample correlation coefficients of all 66 factors with 20 target factors. To evaluate the statistical significance of obtained correlation coefficients, we have applied the t-criteria calculated according to this formula:

$$t = \frac{r \cdot \sqrt{n-2}}{\sqrt{1-r^2}} \qquad (1),$$

where r – Pearson sample correlation coefficient, n – sample volume. Obtained values t criteria were compared with critical value t_{cr} which for sample volume n=42 and statistic importance α=0.05 is 2.021.
As results, we have obtained the list of factors with the statistically significant influence on selected target factors. For instance, the target factor “the force of adductors of right hip” has the strong statistically significant dependence on force abductors right hip and force of extension muscle of left hip (see Table 3). The strong statistically significant dependence is one with correlation coefficient more than 0.7.

Table 3: The factors with strong statistically significant dependence on the force of adductors of right hip

	f_R_B_O	f_L_B_P
Pearson sample correlation coefficient r	0.68	0.93
t criteria	6.17	16.92

Since the number of factor lists with statistically significant correlations is 20, there are too many tables with it, and it can be weekly readable. Therefore we have presented these dependencies as the oriented graph (Figure 1 and 2). The graph contains only strong dependences.

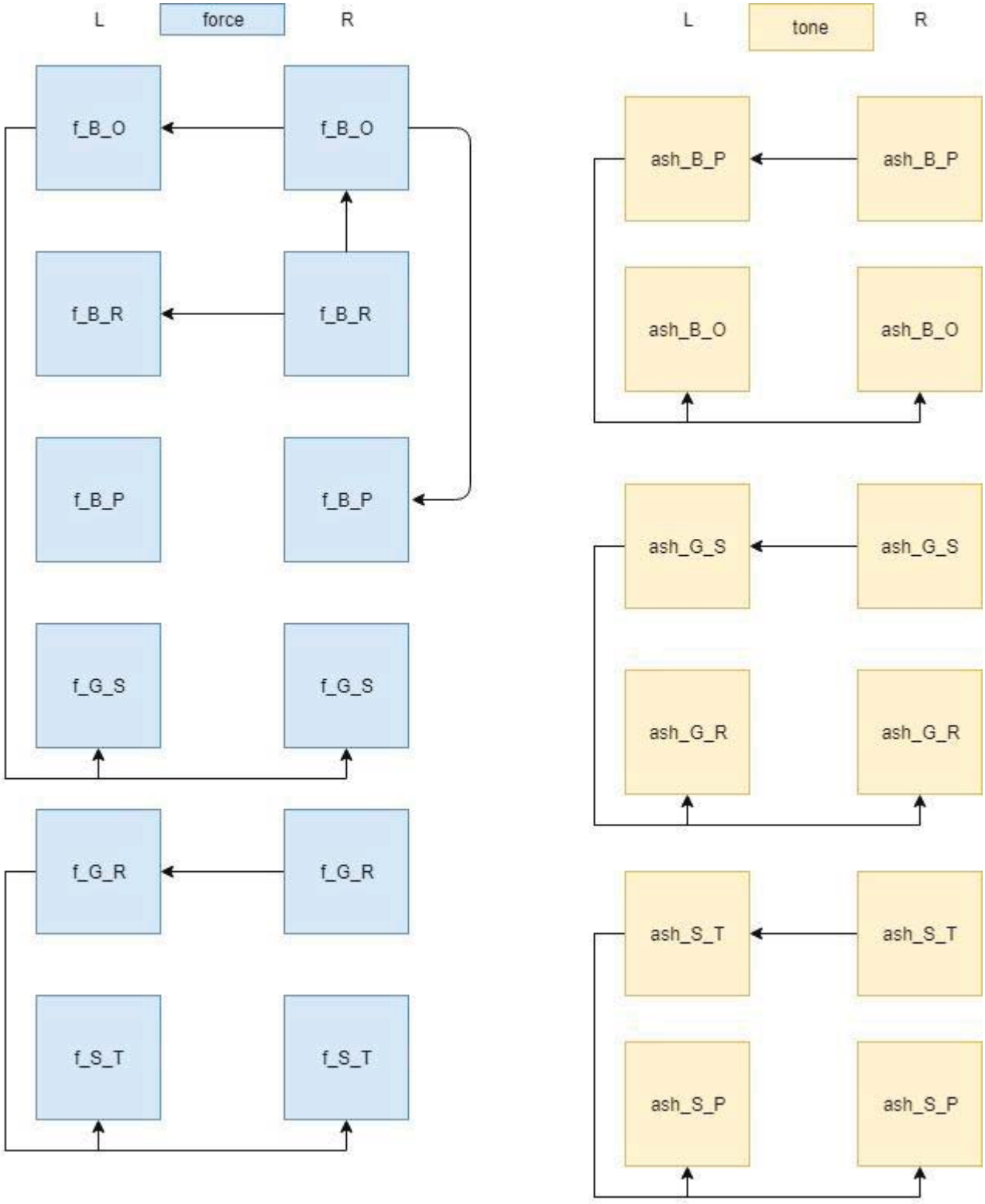

Figure 1: Dependence in force and tone muscle factors

Notes: L – left limb, R – right limb. The rest notations are explained in Table 1.

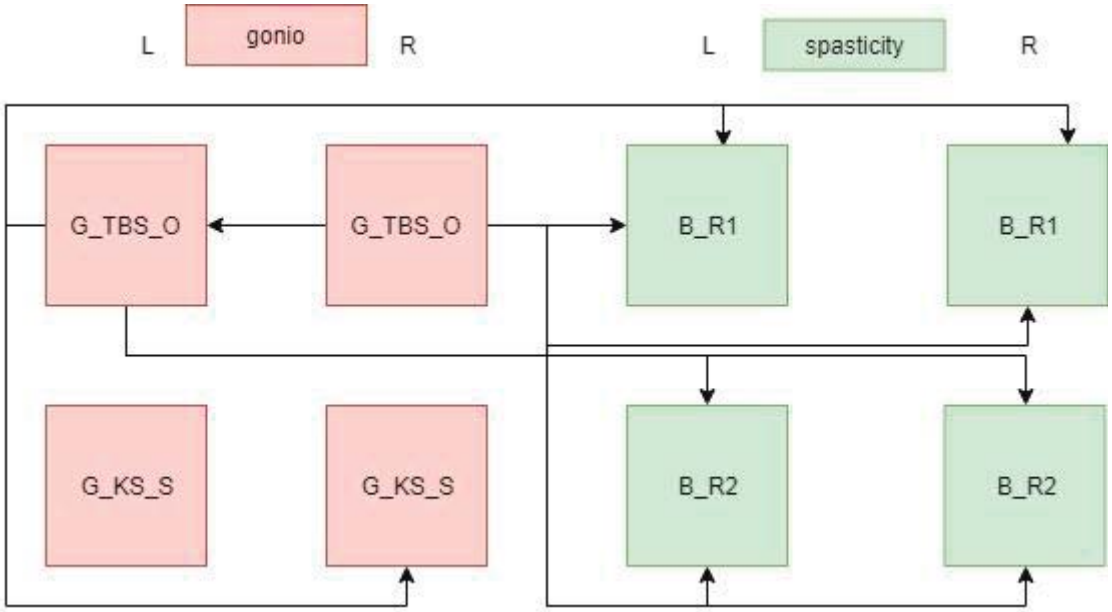

Figure 2: Dependences in goniometry (gonio) and hypertonia (spasticity)

Notes: L – left limb, R – right limb. The rest notations are explained in Table 1.

As can be seen from figure 1, one does not detect statistically significant interference of force muscle and tone muscle, however, there are strong statistically significant dependences between goniometry of joint and hypertonia.

Conclusion

The dependencies between muscle groups on their strength and tone were established by the methods of correlation analysis of clinical data on motor impairment assessment. At the same time, there were no dependences between muscle tone and strength. Dependencies were established between the amplitude of movements in the joints of the lower extremities and the pathologically increased muscle tone. The obtained data are planned to be taken into account in clinical practice when drawing up individual programs for the rehabilitation of children with cerebral palsy.

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