EFFECTS OF FUNCTIONAL ELECTRICAL STIMULATION IN REHABILITATION WITH HEMIPARESIS PATIENTS

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Abstract

Cerebrovascular accident is a focal neurological deficiency occurring suddenly and lasting for more than 24 hours. The purpose of our work is to determine the role of the functional electrical simulation (FES) in the rehabilitation of patients with hemiparesis, which occurred as a consequence of a cerebrovascular accident. This study includes the analysis of two groups of 40 patients with hemiparesis (20 patients with deep hemiparesis and 20 patients with light hemiparesis), a control group which was only treated with kinesiotherapy and a tested group which was treated with kinesiotherapy and functional electrical stimulation. Both groups of patients were analyzed in respect to their sex and age. Additional analysis of the walking function was completed in accordance with the BI and RAP index. The analysis of the basic demographical data demonstrated that there is no significant difference between the control and tested group. The patients of both groups are equal in respect of age and sex. After 4 weeks of rehabilitation of patients with deep and light hemiparesis there were no statistically significant differences between the groups after evaluation by the BI index. However, a statistically significant difference was noted between the groups by the RAP index among patients with deep hemiparesis. After 8 weeks of rehabilitation the group of patients who were treated with kinesiotherapy and functional electrical stimulation showed better statistically significant results of rehabilitation in respect to the control group with both the BI index and the RAP index ($p<0,001$).
In conclusion, we can state that the patients in rehabilitation after a cerebrovascular accident require rehabilitation longer than 4 weeks. Walking rehabilitation after stroke is faster and more successful if we used functional electrical stimulation, in combination with kinesiotherapy, in patients with disabled extremities.

KEY WORDS: rehabilitation, kinesiotherapy, functional electrical stimulation.

Introduction

Cerebrovascular accident is a focal neurological deficiency occurring suddenly and lasting for more than 24 hours. A stroke denotes an acute or subacute appearance of symptoms caused by localized disturbance of arterial brain circulation (1, 2). Among its consequences are hemiplegia or hemiparesis, speech impairment, swallowing impairment, facial nerve changes, sensitivity changes, sphincter control changes, and psychological changes (3). CNS regeneration and restructuring process is believed to occur through the branching of dendrite fibres of nerve brain cells, which occurs in a period of two years after the CVI (4,5,6,7). It is considered that rehabilitation after the CVI influences the stimulation of the penubra zone cells. In highly developed countries, this phase is carried out in the so-called "stroke units" (8,9). This is the first rehabilitation phase, which includes patient care, functional training and kinesiotherapy. The second rehabilitation phase or late rehabilitation is carried out in rehabilitation institutions. The medical rehabilitation program contains a series of procedures including the following: patient care, functional training, kinesiotherapy, electrotherapy, thermotherapy, care for the patient's psychological state, and work therapy. Work therapy is a transitional bridge towards the third rehabilitation phase, which involves the patient's reintegration into his social, family, and (if rehabilitated functions permit) working environment. This phase of rehabilitation is carried out in the patient's home and the role of the family in this phase is vital (10). The main issue is how to accelerate the rehabilitation process after the appearance of hemiparesis, which occurs as a consequence of stroke. For this purpose, it is important to determine whether the use of functional electrical stimulation (FES), in combination with other rehabilitation methods, can help accelerate the functional rehabilitation of a disabled extremity. Adequate rehabilitation is of paramount importance for the patient, family, healthcare and society in general. If the rehabilitation period is reduced, the patient spends fewer days in the hospital, undergoes fewer procedures, which as a result means smaller funds invested in the patient's recovery. With faster rehabilitation, the patient is reintegrated sooner and can actively participate in society and be economically productive. The aim of our study is to determine the role of functional electrical stimulation in the rehabilitation of patients with hemiparesis after a stroke.

Patients and Methods

As a research sample, the author completed a comparative study with two groups of patients, which were treated with different therapeutic procedures. One group consisted of patients who were treated with kinesiotherapy and no other procedure. This was the control group. The second group consisted of patients that were treated with kinesiotherapy and functional electrical stimulation. This was the tested group. Both groups were equal in respect to age and sex. Furthermore, both groups were analyzed by the time which passed between the stroke and the start of the rehabilitation process, as well as by the time which passed when the rehabilitation process at the Institute for Physiotherapy and Rehabilitation of the University of Sarajevo Clinics Centre was completed.

Study inclusion criteria

This research study included patients with a hemiparesis that occurred as a consequence of a stroke. All patients were over 18 years of age and had been diagnosed as stroke patients. Furthermore, all of the patients have participated in rehabilitation at the Institute for Physiotherapy and Rehabilitation of the University of Sarajevo Clinics Centre.

Study exclusion criteria

This study does not include patients who have hemiparesis due to other reasons, are not conscious or are disoriented in time and space, have cardiovascular disease, are in inadequate physical state, have damaged skin at the application region, have no muscle elasticity, experience strong spasms, have other extremity deformities, are not willing to cooperate or participate, or have experienced the occurrence of hemiparesis over three months before the study.

Research methods

In this study we have decided to use the electro-stimulation device developed at the Jožef Stefan Institute in Ljubljana, Model 100 Microfes Personal Kit. Two groups of 40 patients in rehabilitation were formed. Both groups consisted of two sub-groups: 20 patients with deep hemiparesis and 20 patients with light hemiparesis. The control group includes the patients who were only treated with kinesiotherapy. The tested group is composed of patients that were treated with kinesiotherapy and functional electrical simulation of the disabled extermity. The FES method was applied five times per week, each treatment lasting 15 minutes. Both groups were analyzed in respect to age and sex.

Additional analysis of the condition and walk function of the disabled extremity was done according to the BI index (11), as well as to the RAP index (12, 13). The patients' conditions were observed 4 and 8 weeks after the stroke. The results were analyzed according to the above listed criteria and were then compared. All of the patients were therapeutically treated by the same team and on the same location. Patients treated with FES received treatment by the same device and in the same manner, under identical conditions.

Statistical analysis

The Students T-Test was used for statistical analysis. The significance level is p<0,05. The research was completed as a randomized, prospective, clinical comparative study.

RESULTS

Results are given in tables. The main demographical data is graphically presented for both groups of studied patients.

	men	women	total
interval years	37-79	20-82	20-82
N	22	18	40
X	61,477	63,161	62,260
S	8,332	12,523	10,497
S_X	0,805	1,299	0,742
Median	62	66	64,5
Mann-Whitney Rank Sum test	p = 0,012		

TABLE 1. General demographic data for both study groups

	Control group (n=20)	Tested group (n=20)	Total (n=40)
interval	2-6	2-6	2-6
X	4,200	4,300	4,250
S	1,240	1,418	1,316
S_X	0,277	0,317	0,208
Median	4,5	4	4
Mann-Whitney Rank Sum test	p=0,860		

TABLE 2. Results of rehabilitation by BI index after 4 weeks for deep hemiparesis

	Control group (n=20)	Tested group (n=20)	Total (n=40)
interval	4-10	5-12	4-12
X	7,200	8,250	7,725
S	1,609	1,860	1,797
S_X	0,360	0,416	0,284
Median	8	8	8
Mann-Whitney Rank Sum test	p=0,107		

TABLE 3. Results of rehabilitation by BI index after 8 weeks for deep hemiparesis

	Control group (n=20)	Tested group (n=20)	Total (n=40)
interval	12-17	8-16	8-17
X	14,250	13,650	13,950
S	1,970	2,498	2,241
S_X	0,441	0,559	0,354
Median	15	14	14
Mann-Whitney Rank Sum test	p=0,507		

TABLE 4. Results of rehabilitation by RAP index after 4 weeks for deep hemiparesis

	Control group (n=20)	Tested group (n=20)	Total (n=40)
interval	8-14	5-12	5-14
X	10,750	8,450	9,600
S	1,682	1,820	2,085
S_X	0,376	0,407	0,330
Median	10	8	10
Mann-Whitney Rank Sum test	p<0,001		

TABLE 5. Results of rehabilitation by RAP index after 8 weeks for deep hemiparesis

	Control group (n=20)	Tested group (n=20)	Total (n=40)
interval	5-8	5-10	5-10
X	6,700	8,100	7,400
S	1,302	1,252	1,446
S_X	0,291	0,280	0,229
Median	6,5	8	8
Mann-Whitney Rank Sum test	p=0,004		

TABLE 6. Results of rehabilitation by BI index after 4 weeks for light hemiparesis

	Control group (n=20)	Tested group (n=20)	Total (n=40)
interval	8-12	8-13	8-13
X	9,200	11,100	10,150
S	1,361	1,252	1,610
S_X	0,304	0,280	0,255
Median	9	12	10
Mann-Whitney Rank Sum test	p<0,001		

TABLE 7. Results of rehabilitation by BI index after 8 weeks for light hemiparesis

	Control group (n=20)	Tested group (n=20)	Total (n=40)
interval	8-14	8-14	8-14
X	10,100	10,250	10,175
S	1,804	2,291	2,037
S_X	0,403	0,512	0,322
Median	10	10	10
Mann-Whitney Rank Sum test	p=0,935		

TABLE 8. Results of rehabilitation by BI index after 4 weeks for light hemiparesis

	Control group (n=20)	Tested group (n=20)	Total (n=40)
Interval	6-12	4-10	4-12
X	7,600	5,850	6,725
S	1,536	1,599	1,783
S_x	0,343	0,357	0,282
Median	8	6	6
Mann-Whitney Rank Sum test	p<0,002		

TABLE 9. Results of rehabilitation by RAP index after 8 weeks for light hemiparesis

Discussion

Table 1 shows the analyzed data which refers to sex and age for both group of participants (the control and experimental). The analysis of the basic demographical data demonstrated that there is no significant difference between the control and tested group. Both groups are equal in respect to the age and sex of the patients. Our previous work (14) had shown similar results. After analyzing the walk function rehabilitation results for deep hemiparesis after 4 weeks according to the BI index, there is no statistically significant difference between the control and tested group. This data is shown in Table 2. Upon analysis of Table 3, similar results can be observed. BI index analysis of the walk function rehabilitation for deep hemiparesis after 8 weeks for both groups clearly shows that the group of patients who were treated with FES have the same results as the control group. Table 4 displays the results of walk function rehabilitation for deep hemiparesis after 4 weeks of rehabilitation for both the control group which was treated solely with kinesiotherapy and the tested group which was treated with kinesiotherapy and FES. The walk function results were measured by the RAP index. Upon analysis of the walk function rehabilitation results after 4 weeks according to the RAP index, we can conclude that there is no statistically significant difference in the walk function rehabilitation between the control and tested group for deep hemiparesis. After 8 weeks of rehabilitation of both groups of patients with deep hemiparesis, according to the RAP index, we can notice that the tested group of patients which was treated with FES has statistically significant better results in the walk function rehabilitation (control group interval 8-14, tested group interval 5-12). These results are displayed in Table 5. Table 6 shows the walk function rehabilitation results by the BI index for the group with light hemiparesis after 4 weeks of rehabilitation. There is no statistically significant difference between the tested group and the control group. The results are similar to those of the group not treated with FES (control group interval 5-8, tested group interval 5-10). BI index analysis of walk function rehabilitation for light hemiparesis after 8 weeks for both groups clearly shows that the group of patients who were treated with FES has statistically significantly better results ($p < 0,001$). That shows better results of the rehabilitation, which is shown in Table 7. Analysis of walk function rehabilitation after 4 weeks for both groups of patients with light hemiparesis, according to the RAP index, shows us that there is no statistically significant difference in favour of the group which was treated with FES (interval for the control group is 8-14, for tested group 8-14, and p is equal to 0,935). This can be observed in Table 8. However, Table 9 displays different data which shows walk function rehabilitation results after 8 weeks by the RAP index. It can be observed that the tested group of patients which was treated with FES has statistically significant better results for walk function rehabilitation after 8 weeks of rehabilitation for light hemiparesis according to the RAP index. The analysis of walk function rehabilitation, according to the BI and RAP indexes, brings us to the conclusion that after 4 weeks of rehabilitation there were no statistically significant differences between the two studied groups of patients (14). Our study shows the same results for deep and light hemiparesis. However, after 8 weeks there is a noticeable, statistically significant difference in the rehabilitation results, by both the BI and RAP index, in favour of the group which was treated with kinesiotherapy and functional electrical simulation (14). It is our opinion that the patients in rehabilitation after a cerebrovascular accident require a rehabilitation which is longer than 4 weeks. The other works had the same results (15,16,17). The above listed results bring us to the conclusion that we can obtain better results of walk function rehabilitation with the tested group, which was treated with kinesiotherapy and FES.

Conclusion

We can conclude that patients in rehabilitation after a cerebrovascular accident require rehabilitation longer than 4 weeks. Walking rehabilitation after stroke is faster and more successful with functional electrical stimulation, in combination with kinesiotherapy, in patients with disabled extremities.

List of Abbreviations

CNS	-	central nervous system
CVI	-	cerebrovascular insult
BI Index	-	Barthel Index- is a test which evaluates everyday life activity
RAP Index	-	Rehabilitation Activity Profile- is a test which evaluates everyday life activity
FES	-	Functional Electrical Stimulation- is a nerve stimulation procedure
T-Test	-	The Students T-Test is a test for statistical analysis of data

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