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EFFECTIVENESS OF COMBINED REHABILITATION INTERVENTION FOR UPPER LIMB FUNCTION IN CHRONIC STROKE

Ilona Ilinca (a), Germina Cosma (b)*, Eugenia Roşulescu (c), Mircea Dănoiu (d)
*Corresponding author

(a) University of Craiova, 156 Brestei St., Craiova, Romania
(b) University of Craiova, 156 Brestei St., Craiova, Romania
(c) University of Craiova, 156 Brestei St., Craiova, Romania
(d) University of Craiova, 156 Brestei St., Craiova, Romania,

Abstract

Introduction: Reducing disability and improving upper limb function after stroke often involve several different interventions and require the co-operation of the patient and rehabilitation team. Goal: To determine whether the combination of rehabilitation (physical/aquatic therapy – PT/AT) and occupational therapy (OT) yielded better results in the treatment of chronic stroke sequelae than physical/ aquatic therapy intervention concurrent with electrical stimulation. Materials and methods: The study included 42 post-stroke hemiplegic patients undergoing treatment at the "Sf. Maria" Neuromotor Rehabilitation Centre, Craiova, and was conducted between November 2016 and December 2017. The subjects were randomly distributed into two groups: group 1 consisted of 21 patients who underwent physical/aquatic therapy plus OT, and group 2 consisted of 21 patients who underwent physical/aquatic therapy plus electrical stimulation. The functional status of hemiplegic patients was evaluated by applying the Rivermead Test, and their motor function (upper extremity) was evaluated by using the Fugl-Meyer Test. Results: Both types of intervention showed statistically higher functional change scores. Rivermead and Fugl-Meyer scores were higher ($p = 0.01$) for subjects who received PT/AT and OT versus patients only receiving PT and TENS (Transcutaneous Electrical Nerve Stimulation). Conclusion: We found an improvement in the upper-limb functional state of our patients with chronic stroke after combination of physical/aquatic therapy and occupational therapy. The application of this treatment combination proved to be more effective in restoring the function of the affected arm, inducing clinically meaningful functional improvement compared to the application of PT/AT therapy and TENS.

Keywords: Chronic stroke, upper limb, rehabilitation interventions..

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1. Introduction

Due to their severity, frequency and consequences, cerebrovascular accidents are the most important chapter of the brain pathology in the elderly. Stroke is a heterogeneous and multi-factorial disease determined by the combination of vascular risk factors, environment and genetic factors. It is defined as a clinical syndrome with rapidly developing signs of focal or global disturbance of cerebral functions lasting more than 24 hours and is a leading cause of serious long-term disability worldwide (Benjamin et al., 2017). This disease is a real health problem, not only through the high mortality rate, but also through the consequences on the motor and cognitive performance of survivors. The sequelae of stroke may have catastrophic effects on the quality of life of the patient and his/her family. Romania has the 3rd highest rate of death from stroke in Europe – 156.8 deaths per 100,000 inhabitants annually (Stroke Alliance for Europe, 2017).

After a cerebrovascular accident, many survivors experience some form of functional impairment that requires complex and modern investigation in specialised services with qualified medical assistance and a period of rehabilitation. The aim of physiotherapy in stroke is to reach the highest possible level of functional independence. It is important to achieve rehabilitation through a set of increasingly performing active methods, which initially focused on maintaining and bringing patients back to a satisfactory physical and neuropsychological state, and then, progressively and systematically, on motor and psychological rehabilitation, followed by the socio-professional reinsertion of patients with various disabilities. The integration of physiotherapy, occupational therapy and aquatic therapy in the rehabilitation of stroke allows for variety, effectiveness and movement repetition.

The loss of upper limb function is among the most common neurological sequelae of stroke (Kim & Shim, 2015). There are numerous studies that cover both standard treatment methods (stretching, Muscle Strengthening Exercises, Motor learning, the concepts of Bobath, Kabat, Rood and Brunnstronn), and innovating rehabilitation techniques (non-invasive brain stimulation, robot-assisted therapy, virtual reality immersion and gaming) used to improve upper-extremity motor function in stroke patients (Hatem et al., 2016.

2. Problem Statement

In spite of all efforts of the researchers to prove that some treatment "works", no neurorehabilitation approach is allocated and proven to be a single "cure" or optimum treatment for rehabilitation after stroke (Hatem et al., 2016; De Wit et al., 2007). Reducing disability and improving upper limb function after stroke often involve several different interventions and require the co-operation of the patient and rehabilitation team.

Aquatic therapy can potentially facilitate independence by providing buoyancy-assisted movements and movement in a supportive environment. The use of the aquatic environment for therapy can improve a patient's ability to effectively perform ADLs (Activities of Daily Living) and IADLs (Instrumental Activities of Daily Living) by augmenting strength, endurance, difficult kinematic patterns and overall physical condition (Park et al., 2016).

Occupational therapy is dominant in assisting people to engage in daily life activities and is an integral part of comprehensive rehabilitation (Landi et al., 2006).

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3. Research Questions

3.1. Hypothesis of the research

A combined program of rehabilitation for people with stroke sequelae can lead to a greater improvement in the motor function.

4. Purpose of the Study

The aim of the study was to determine whether the combination of rehabilitation (physical/aquatic therapy – PT/AT) and occupational therapy (OT) yielded better results in the treatment of chronic stroke sequelae than physical/aquatic therapy intervention concurrent with Neuromuscular Electrical Stimulation (NMES).

5. Research Methods

The study was conducted as a randomised pre-test and post-test group design that arbitrarily assigned participants into experimental groups. The study included 42 patients, 64% male and 46% female, with age range from 42 to 83 years, diagnosed with hemiplegia due to stroke, undergoing treatment at the “Sf. Maria” Neuromotor Rehabilitation Centre, Craiova, and was conducted between November 2016 and December 2017. During the research, 5 patients were excluded from the first randomly chosen sample of subjects, because they were not regular in visiting the rehabilitation unit, so the final sample for the study comprised a total of 42 patients. Left hemiplegia was found in 88% of patients and 12% had a right-sided deficit, while 97% had been right-handed before the stroke.

Local ethical permission was given by the Ethics Commission of the University of Craiova. All participants provided their written informed consent prior to their inclusion in the study, in accordance with the ethical principles of the Declaration of Helsinki. The subjects were randomly distributed into two groups: group 1 consisted of 21 patients who underwent physical/aquatic therapy plus OT, and group 2 consisted of 21 patients who underwent physical/aquatic therapy plus neuromuscular electrical stimulation.

The functional status of hemiplegic patients was evaluated by applying the Rivermead Test, and their motor function (upper extremity) was evaluated by using the Fugl-Meyer Test.

The Rivermead Motor Assessment Test (RMA) is an assessment tool for motor performance. It includes 38 items of increasing difficulty representing 3 domains: gross function (13 items), leg and trunk movement (10 items) and arm movement (15 items). Each item on the RMA is coded 0 or 1, depending on whether the patient does the activity according to specific instructions. Scores range from 0 to 38, with higher scores indicating better motor ability (Kurtais et al., 2009). Only the upper-limb movement subscale was used in our study.

The Fugl-Meyer Assessment Test (FMA) is an assessment tool for motor functioning following a stroke. The scale consists of five domains and there are 155 items in total: Motor functioning (in the upper and lower extremities), Sensory functioning (evaluating light touch on two surfaces of the arm and leg, and position sense for 8 joints), Balance (containing 7 tests – 3 seated and 4 standing), Joint range of motion (8 joints), Joint pain. Maximum score is 226 (66 for upper extremity, 34 for lower extremity, 14 for balance, 24 for sensation, 44 for range of motion and 44 for pain) (Fugl-Meyer, Jääskö, Leyman, Olsson, & Steglind, 1975). For patient assessment, we used only the corresponding items of motor functioning evaluation in the

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upper extremity score. The Fugl-Meyer Assessment, upper extremity section (FMA-UE), grades motor impairments (ICF – International Classification of Functioning, Disability and Health – muscle and movement functions) of the arm and hand after stroke in terms of reflex activity, synergetic patterns of movement, ability to perform isolated movements, wrist and grip functions, coordination and speed.

The participants were assessed at baseline, six and twelve months after therapy using the Rivermead Motor Assessment Test and the Fugl-Meyer Test, respectively.

All patients participating in this study received the same physical and aquatic therapy program lasting 1 h/session, three sessions per week, for 10 successive months. The aquatic exercise was performed in the swimming pool of the "Sf. Maria" Neuromotor Rehabilitation Centre. The therapy pool was located inside the facility; the 12x5m pool was uniformly 1.4m deep and heated to 32-32.5°C.

In Group 1, the patients performed aquatic or land-based exercises (a 50-minute session, three days/week) in conjunction with occupational therapy (a 30-minute session, three days/week).

Aquatic exercises for upper limb included activities focused on techniques to decrease muscle tone and improve upper extremity function and joint mobility, strengthening exercises to improve and maintain the integrity of muscles. To address the patient's upper extremity tone, passive range of motion (ROM) using proprioceptive neuromuscular facilitation (PNF), D1 and D2 extension pattern, was provided with the entire extremity submerged. The therapist utilised rhythmic rotation and deep pressure to the distal biceps tendon to encourage muscle relaxation.

Aquatic sessions also included gait training, balance- and coordination-enhancing exercises, as well strength, flexibility and endurance training. Exercises were individualised for each participant based on the number of repetitions and the intensity level the patients were capable of. Progression was also scheduled on an individual basis.

5.1. The program intervention

The exercise intervention for improving upper-limb motor function included manual passive stretching for spastic muscles (elbow and wrist flexors), which was based on passive ROM therapeutic exercises, Bobath intervention and the PNF concept to reduce muscle tone. Hand weight-bearing exercises for both upper limbs, as well as ROM exercises and proprioceptive training, were also applied from positions of sitting or side-sitting on a mat and/or sitting on a roll. Bilateral exercise was also used in order to promote functional recovery of the damaged limb through the interlimb coupling effect. Strengthening exercises for the elbow and wrist extensors using different objects and motivation to encourage the patient to perform the desired exercises were also part of our physical therapy.

Occupational therapy based on exercises facilitating hand skill patterns included basic reach, grasp, carry and release and the more complex skills of in-hand manipulation and bilateral hand use. The therapist guided and assisted the patient to perform the exercises correctly. Exercises included the following: reach, initially with both hands and then with each hand, an object presented at midline; reach, with 45° and 90° shoulder flexion, neutral rotation of humerus, elbow extension and forearm supination to mid position; reach across midline while keeping an erect trunk; use a sustained palmer and pincer grasp with wrist extension; encourage elbow and wrist extension releasing objects into container at arm length from the child's body, using both hands together to push, carry or lift large objects, and throwing the ball unilaterally or bilaterally.

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Group 2 received the same exercise/aquatic therapy program given to group 1, in addition to neuromuscular electrical stimulation. Wrist/fingers and elbow flexors were targeted in upper extremities and stimulation intensity was increased to patient tolerance.

6. Findings

The statistical analysis of the research data was performed using the SPSS software, version 21, for descriptive statistics. Both intragroup and intergroup were presented using the paired t-test and independent t-test to determine the difference between the first and second evaluation. A p-value <0.05 was considered statistically significant.

Table 01 shows the results of group 1 for the initial and final evaluations. The mean for the first evaluation in Rivermead Test was 7.52 (±1.29). After introducing PT/AT plus OT rehabilitation programs for group 1, the mean value was 8.92 (±1.04) in the final test. The paired t-test applied for the initial and final evaluations revealed that the mean difference was 1.40, t-value -6.35, and the degrees of freedom 41, the 95% confidence interval for the difference ranging from -1.85 to -0.95. The difference is statistically significant at a 5% significance level, the bidirectional threshold being p<0.001.

For the Fugl-Meyer Test, the initial mean was 48.30 (±1.02) and 53.54 (±0.86) in the final evaluation. The paired t-test applied for the initial and final evaluation revealed that the mean difference was -5.23, t-value -34.53, and the degrees of freedom 41, the 95% confidence interval for the difference ranging from -5.54 to -4.93. The difference is statistically significant at a 5% significance level, the bidirectional threshold being p<0.001.

Table 01. Descriptive statistics for Group 1

Tests	Group 1 (n=21)	t	p-value
Rivermead Test T1	7.52 (±1.29)	-6.356	0.001
Rivermead Test T2	8.92 (±1.04)		
Fugl-Meyer Test T1	48.30 (±1.02)	-34.53	0.001
Fugl-Meyer Test T2	53.54 (±0.86)		

Table 02 shows the results of group 2 for both evaluations. The mean for the first evaluation in Rivermead Test was 7.04 (±1.12) and 8.11 (±0.83) in the final test. The paired t-test applied for the initial and final evaluations revealed that the mean difference was -1.07, t-value -5.21, and the degrees of freedom 41, the 95% confidence interval for the difference ranging from -1.48 to -0.66. The difference is statistically significant at a 5% significance level, the bidirectional threshold being p<0.001.

For the Fugl-Meyer Test, the initial mean was 47.84 (±1.05) and 52.02 (±1.43) in the final evaluation. The paired t-test applied for the initial and final evaluations revealed that the mean difference was -1.07, t-value -18.01, and the degrees of freedom 41, the 95% confidence interval for the difference ranging from -4.87 to -3.88. The difference is statistically significant at a 5% significance level, the bidirectional threshold being p<0.001.

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Table 02. Descriptive statistics for Group 2

Tests	Group 2 (n=21)	t	p-value
Rivermead Test T1	7.04 (±1.12)	-5.21	0.001
Rivermead Test T2	8.11 (±0.83)		
Fugl-Meyer Test T1	47.84 (±1.05)	-18.01	0.001
Fugl-Meyer Test T2	52.02 (±1.43)		

As can be seen in Table 01 and Table 02, both groups show a significant improvement in the motor function of the affected arm in the final test, the combination of physical/aquatic therapy and occupational therapy program having a good influence on the upper-limb functional state.

Table 03. Independent Samples t-Test (intergroup G1/G2)

Tests	Group 1/ Group 2 t-value	p-value (2-tailed)
Rivermead Test T1	1.80	0.075
Rivermead Test T2	3.92	0.001
Fugl-Meyer Test T1	3.02	0.054
Fugl-Meyer Test T2	5.88	0.001

Table 03 shows the results of group 1 versus group 2, for Rivermead and Fugl-Meyer tests; no significant differences between the two intervention groups ($p>0.05$) were noted at the beginning of the research. In the final test, there were statistically significant differences between the results of the two groups, group 1 having better results after implementation of the aquatic or land therapy in conjunction with occupational therapy.

Taking into account the diversity of stroke patients, treatment interventions may vary according to medical or therapeutic disciplines, professional practices and facilities (Lewis, 2003). Poor recovery of upper limb may be the effect of the direct impact of the stroke itself, as well as of inappropriate or insufficient rehabilitation treatment (Carr & Shepherd, 2011). According to another study (Duncan et al., 2011), one year after stroke, 52% of all patients improve functional walking ability and, in only 15%, hand function fully recovers at six months post-stroke; about 65% of patients still cannot incorporate the affected arm and hand into their daily activities (Dobkin, 2005).

In this article, there were evaluated the effects of physical/aquatic therapy applied in combination with occupational therapy or electrical stimulation in stroke patients during the chronic rehabilitation period.

Other research has shown that combined aquatic therapy and traditional rehabilitative interventions can help patients by improving specific functional abilities beyond traditional occupational therapy alone (Eversden, Maggs, Nightingale, & Jobanputra, 2007).

In combination with rehabilitation treatment, therapeutic electrical stimulation after stroke may allow potentiating patient recovery and can be used as an adjuvant intervention for rehabilitation treatment. Several studies have examined whether the addition of cyclical NMES to standard physiotherapy is superior to standard physiotherapy alone. Studies of NMES in chronic hemiplegia have typically been relatively small case series designs, but have also demonstrated improvements in various upper-limb motor impairment measures (Hendricks, Ijerman, de Kroon, in't Groen, & Zilvold, 2001; Santos, Zahner, McKiernan, Mahnken, & Quaney, 2006).

No significant differences (p>0.05) were found at baseline between the groups in terms of age, sex, duration from stroke onset, handedness, affected side, RMA and FMA scores.

The results of our study found that motor function and performance of the affected arm significantly (p < 0.01) improved in the two studied groups, both after physical/aquatic therapy combined with occupational therapy and after physical/aquatic therapy combined with NMES. When the two groups were compared, group 2 demonstrated significantly greater gains between baseline, 6 months and 12 months over all outcome measures and specifically in the Rivermead Motor Assessment Test. Upper limb function measured with the Fugl-Meyer Assessment Test improved in all groups, but the improvement was less for the second group compared to group 1. Both groups received one hour of physical/aquatic therapy 3 times a week, but group 1, who additionally received occupational therapy, improved more on measures of upper limb function.

7. Conclusion

It has been found an improvement in the upper-limb functional state of our patients with chronic stroke after combination of physical/aquatic therapy and occupational therapy. The application of this treatment combination proved to be more effective in restoring the function of the affected arm, inducing clinically meaningful functional improvement compared to the application of PT/AT therapy and NMES.

References

Benjamin, E. J., Blaha, M. J., Chiuve, S. E., Cushman, M., Das, S. R., Deo, R., … Munter, P. (2017). Heart disease and stroke statistics – 2017 update: A report from the American Heart Association. *Circulation, 135*(10), 146-603.

Carr, J. H., & Shepherd, R. B. (2011). Enhancing physical activity and brain reorganization after stroke. *Neurology Research International*. doi: 10.1155/2011/515938

De Wit, L., Putman, K., Schuback, B., Komárek, A., Angst, F., Baert, I., … De Weerdt, W. (2007). Motor and functional recovery after stroke: A comparison of 4 European rehabilitation centers. *Stroke 38*(7), 2101-2107.

Dobkin, B. H. (2005). Rehabilitation after stroke. *The New England Journal of Medicine, 352,* 1677-1684.

Duncan, P. W., Sullivan, K. J., Behrman, A. L., Azen, S. P., Wu, S. S., Nadeau, S. E., … Hayden, S. K. (2011). Body-weight-supported treadmill rehabilitation after stroke. *The New England Journal of Medicine, 364*(21), 2026-2036.

Eversden, L., Maggs, F., Nightingale, P., & Jobanputra, P. (2007). A pragmatic randomised controlled trial of hydrotherapy and land exercises on overall wellbeing and quality of life in rheumatoid arthritis. *BMC Musculoskeletal Disorders, 8*: 23. doi: 10.1186/1471-2474-8-23

Fugl-Meyer, A., Jääskö, L., Leyman, I., Olsson, S., & Steglind, S. (1975). The post-stroke hemiplegic patient. I. A method for evaluation of physical performance. *Scandinavian Journal of Rehabilitation Medicine, 7*(1), 13-31.

Hatem, S. M., Saussez, G., Della Faille, M., Prist, V., Zhang, X., Dispa, D., & Bleyenheuft, Y. (2016). Rehabilitation of motor function after stroke: A multiple systematic review focused on techniques to stimulate upper extremity recovery. *Frontiers in Human Neuroscience, 10*: 442. doi: 10.3389/fnhum.2016.00442

Hendricks, H. T., Ijerman, M. J., de Kroon, J. R., in't Groen, F. A., & Zilvold, G. (2001). Functional electrical stimulation by means of the 'Ness Handmaster Orthosis' in chronic stroke patients: An exploratory study. *Clinical Rehabilitation, 15*(2), 217-220.

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Corresponding Author: Germina Cosma
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

Kim, H., & Shim, J. (2015). Investigation of the effects of mirror therapy on the upper extremity functions of stroke patient using the manual function test. *Journal of Physical Therapy Science, 27*(1), 227-229.

Kurtais¸ Y., Küçükdeveci, A., Elhan, A., Yilmaz, A., Kalli, T., Tur, B. S., & Tennant, A. (2009). Psychometric properties of the Rivermead Motor Assessment: Its utility in stroke. *Journal of Rehabilitation Medicine, 41*(13), 1055-1061.

Landi, F., Cesari, M., Onder, G., Tafani, A., Zamboni, V., & Cocchi, A. (2006). Effects of an occupational therapy program on functional outcomes in older stroke patients. *Gerontology, 52*(2), 85-91.

Lewis, S. C. (2003). Physical disabilities and occupational therapy intervention approaches. In *Elder care in occupational therapy* (pp. 183-197). Thorofare, NJ: Slack, Inc.

Park, B. S., Noh, J. W., Kim, M. Y., Lee, L. K., Yang, S. M., Lee, W. D., … Kim, J. (2016). A comparative study of the effects of trunk exercise program in aquatic and land-based therapy on gait in hemiplegic stroke patients. *Journal of Physical Therapy Science, 28*(6), 1904-1908.

Santos, M., Zahner, L. H., McKiernan, B. J., Mahnken, J. D., & Quaney, B. (2006). Neuromuscular electrical stimulation improves severe hand dysfunction for individuals with chronic stroke: A pilot study. *Journal of Neurologic Physical Therapy, 30*(4), 175-183.

Stroke Alliance for Europe. (2017). *The burden of stroke in Europe. The challenge for policy makers*. Retrieved from https://www.stroke.org.uk/sites/default/files/the_burden_of_stroke_in_europe_-_challenges_for_policy_makers.pdf