Effects of Facilitation Exercise Techniques in Stroke Rehabilitation

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A group of randomly selected patients with hemiplegia from stroke were exposed to a specified therapeutic exercise program utilizing neuromuscular “reeducation" techniques based on neurophysiological and/or developmental theories. Results were compared with those in a control group of persons who had received a similar program which did not contain these exercises. Patients in both groups were alike in their major clinical characteristics, and were evaluated using objective. quantitative test methods developed at The Burke Rehabilitation Center. In addition, a numerical self-care scoring system (Kenny Rehabilitation Institute Self-Care Evaluation) was used to assess functional improvement.

This Study indicates that facilitation exercises do not significantly improve the motility and strength deficits observed in these patients. because both groups showed comparable improvement. It can be concluded that these therapeutic exercises as outlined in this Study do not improve motility and strength in patients with stroke.

Therapeutic exercises have been employed in an effort to improve hemiplegia in patients following a stroke. These "specialized therapeutic exercises" are neuromuscular "reeducation" techniques based on neurophysiological and/or developmental theories. Such treatment approaches have been introduced in the past decade by Fay, Bobath, Kabat and Knott, Rood, and Brunnstrom. The use of these methods has created considerable controversy because of their neurophysiological rationale and efficacy in stroke rehabilitation. Neither the proponents nor the physical therapists who employ these treatment modalities have made a serious attempt to evaluate their effectiveness in controlled studies. In conditions where spontaneous improvement is known to occur, evaluation of therapeutic measures is difficult. With increasing public and official concern over rising health care costs and shortage of trained ancillary personnel, a critical appraisal of rehabilitation procedures is needed.

The primary objective of this study was to determine whether improvement shown by a group of patients having stroke treated with a rehabilitation program which included the "specialized exercises" referred to, was significantly greater than the improvement of another comparable group who received a similar program which did not include these exercises.

Materials and Methods

PATIENTS

Sixty-two patients with completed stroke and hemiplegia were admitted to The Burke Rehabilitation Center in 1968-1969. "Stroke" was defined as the neurologic result of an ischemic lesion in a cerebral hemisphere caused by arteriosclerotic or embolic arterial occlusion. Cerebral hemorrhage and other causes of hemiplegia were excluded. On admission 50 patients were divided by a random process into two groups: Group A (control group) received no "specialized" therapeutic exercises, and Group B (exercise group) was treated with a specialized special therapeutic exercise program, the details of which are described in the Appendix. In all other details the treatment program for the two groups was identical.

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To obtain valid results at the conclusion of the study, it was essential that the control group and exercise group be balanced. Twelve patients were added to the randomly selected groups by assignment to even out differences in the important characteristics listed in table 1, which might be expected to influence a patient's response to treatment. These characteristics include age, sex, side of hemiplegia, duration of illness, and the presence of concomitant disease. It can be seen that the two groups are evenly matched for these factors. However, the total population was biased to the extent that patients with right hemiplegia and severe aphasia who were unable to follow instructions or simple commands were omitted from the study (five patients).

THERAPEUTIC EXERCISES

The details of the program of therapeutic exercises are given in the Appendix. These treatment specifications were compiled by a senior physical therapist in collaboration with the physical therapy staff of The Burke Rehabilitation Center and other institutions. The treatment program was a reasonable and practical approach to the utilization of these procedures. Treatment schedules were strictly controlled and given daily on week days for the duration of hospitalization. On occasion resistance was encountered on the part of some physical therapists who were strongly biased in favor of these exercises. In general, the physiotherapists were cooperative and interested in evaluating this program of physical therapy.

METHODS OF EVALUATION

Because of the difficulty in measuring improvement in patients with hemiplegia in a treatment program designed to improve strength and skill of motility performance, three methods of evaluation were used which we believed could accurately measure change in these parameters: (1)quantitative testing of motility defects, (2)strength measurements, and (3)functional evaluation.

Quantitative Testing of Motility Defects

Defects-An objective test of motility function was developed to minimize observer bias. The equipment allows the electro-

Table 1: Characteristic of 62 Patients

	Control group (31 patients)	Exercise group (31 patients)
Age. Yr. (mean)	64.4(Range: 46-84)	63.5(Range: 38-77)
Sex: Male, no.	19	19
Female, no.	12	12
Left hemiplegia, no. of patients	17	17
Right hemiplegia, no, of patients	14	14
Days, onset to admission (median)	33 (Range: 8dasys to 5 years)	29 (Range 13days to 2.25 years)
motility index (mean)		
Involved side	-18.3	-19.3
Uninvolved side	-7.4	-6.9
leg strength (knee flexors and extensors)		
In torwue (mean)		
Involved side	31.3 ft./lbs.	23.2 ft./lbs.
Uninvolved side	76 ft./lbs.	74.1 ft./lbs.
functional evaliation (KIR scale)	10.7	9.8
Depression, reactive	9	3
Chronic brain syndorme, mild to moderate	7	6
Heart disease	21	14
Diabetes mellitus	10	8
Dysphasia	12	7
Hypertension	24	22
Other significant associated conditions(i.e. arthritis, impaired vision, genitourrinary complications)	9	12

*Based on vital sintistincs, quantitative measurements of motility and strength, functional evaluation and associated sonditions, the control group and the exercise group proved to be equally matched.

**Kenny Rehabilitation Institute Self-Care Evaluation

mechanical recording of tapping rate and accuracy of motor function of distal and proximal muscle groups of arms and legs. The sum of the scores of performance of all four extremities is expressed in the Motility Index (MI). In a previous publication[6] the details of the methodology and the results of standardization procedures are described. The Ml has the property that a normal motility score is 0; less than normal motility gives a negative score, and better than normal motility gives a positive score. Motility subindices can be obtained for either side of the body and for either the upper or lower extremities. Values for the following hypothetical cases can be inferred from the standardization: a complete left hemiplegia, with an uninvolved right side, would give a score of -21.5; a complete right hemiplegia, with an uninvolved left side, would give a score of -23.3 ; and a quadriplegia would give a score of -44.8.

Although the test battery was applied at weekly intervals, only values obtained upon admission and discharge were used in the statistical comparison of the two groups in this study. The test battery could be administered even in the presence of some degree of aphasia or dementia. Previous analysis of the test has shown that there was neither a learning nor a boredom effect on repeated testing.

Strength Measurements- Strength measurement were limited to the leg because the dynamometer used was not easily applicable for testing the upper extremity in patients with hemiparesis from stroke. The strength in foot pounds of the knee extensors and flexors was measured using the Cybex Torque Dynamometer. The muscle groups were functionally isolated for the test by body position and leg immobilization by having the patient seated

on a plinth, modified specifically for this purpose.

The results of the best of three trials recording peak torque at a constant speed of 2 rpm. were used. Recording of strength was made on admission, at weekly intervals thereafter, and discharge from the hospital. Leg strength was defined as the sum of the values obtained for both knee flexion and extension. For statistical comparison of the two groups, only the values found on admission and at discharge were used.

Functional Evaluation- For the functional evaluation, the numerical self-care scoring system of The Kenny Institute of Rehabilitation (KIR scale) as described by Schoening and Iversen, was used. In this study, nurses rated the patients for all items except stair climbing. The occupational therapists rated patients for all items except stair climbing and personal hygiene. The physical therapists rated patients for transfer and locomotion activities including stair climbing. Activities of daily living were evaluated by personnel who had maximum contact with patients during the time particular activities were performed. There was considerable overlap in observation and rating, allowing a more careful evaluation of a patient's activity, The Kenny Self-Care Index is based on evaluations of 17 different self-care activities, and the subscores are combined to give a single index which ranges from 0 to 24. Higher value indicates complete or nearly complete independence in the activities of daily living. Rating was done upon admission, at bimonthly intervals, and at discharge; but only initial and final values were examined in detail.

Interrater discrepancies were occasionally observed and averaged. An interrater reliability study was conducted before the KIR scale was adapted for our purposes. The Kendall coefficient of concordance was utilized (N= 8, w= 0.868, p less than 0.02). From this study, using this form of analysis, it was concluded that the agreement between raters was reasonable.

Results

CHANGES IN MOTILITY

The mean change in the Ml of patients in the control group compared with that in the exercise group was 2.4 and 2.9 respectively. The changes in the Ml

represent the differences between the initial and final scores.

These figures do not demonstrate differences in the degree of improvement between the patients who received the special therapeutic exercises and those who did not receive this program of treatment.

Table 2: Changes in the Motility Index, Paretic Compared to the Nonparetic Side

	Mean charge	Range of charge
Involved side	2.6	-1.5 to 13.3
Uninvolved side	2.9	-3.5 to 9.3

Table 2 compares the improvement in the hemiparetic side (involved side) with that in the nonparetic side (uninvolved side). For this data presentation, the scores for both the control and the exercise groups are pooled. The scores for the hemiparetic sides of all patients are compared to those for the nonparetic sides of all patients.

The degree of improvement observed in these patients appeared about equal in the paretic and nonparetic extremities. The change in total motility indices reflected changes in motility function of both sides.

LEG STRENGTH MEASUREMENTS

Torque dynamometry measurements of the knee flexors and extensors of the patients in the control and exercise groups revealed 15.7 ft./ lbs. and 19.6 ft./ lbs. respectively. Leg strength is defined as the difference between the initial and the final score. The changes in strength for both groups were about equal.

The change in leg strength for the involved (paretic) side compared to the uninvolved (normal) side was calculated for all of the patients in both the control and exercise groups. Table 3 shows the results of this comparison. Leg strength improved in both the paretic and nonparetic lower extremities.

Table 3: Changes in Leg Strength, Paretic Side Compared to Nonparetic Side

	Mean change	Range Of chance
Involved side	17.7	--27 to 101
Uninvolved side	15.5	--34 to 80

Strength measurements are difficult to interpret owing to the high variance of the data. The special exercise group showed a slight trend toward higher values but the difference was small and is presumed to have no clinical importance.

FUNCTIONAL EVALUATION

Important functional improvement in the activities of daily living was noted in both groups. Table 4 shows the results from the treated and control groups. Although considerable improvement in these scores was seen in both groups, the differences in achievement are not marked.

Table 4: Functional Improvement (KIR Scale*) in Activities of Daily Living, Control Compared to Exercise Group

Mean	Control group	Exercise group
Initial	10.7	9.8
Final	19.0	19.5
Change	8.3	9.7

•Kenny Rehabilitation Institute Self-Care Evaluation.

Table 5: Duration of Hospitalization, Control and Exercise Group Compared

Group	Mean. days	Median. days
Control	55.7	54
Exercise	63.3	60

A degree of improvement in self-care status is usual for stroke victims followed for extended periods of time. As both our control and the treatment group improved to about the same degree, it appears that specialized exercises do not influence the final functional outcome. These observations are in accordance with those made by Feldman and associates. This conclusion would be irrelevant if the duration of hospitalization were significantly shorter for the group receiving specialized exercises as compared with a control group. The means and medians for the length of stay are listed in table 5.

Patients in the exercise group actually had a longer hospital stay than those in the control group.

From the measurements made during the stay of each patient in the hospital, two were subjected to statistical analysis: (1) The difference between the final and initial motility indices from the paretic side; and (2) the difference between final and initial leg strength on the paretic side.

The variance of the data was quite high, and it clearly departed from the normal distribution. Therefore, the principal analysis was made using a nonparametric test based on the bivariate Mann-Whitney statistic.

The null hypothesis for our problem is that improvement for patients in the control group was the same as that for the exercise group. An alternative hypothesis would be that the exercise group showed a greater improvement, according to our measures, than the control group. Both of these hypotheses are based on the premise that both groups of patients were drawn from the same population based on our analysis of important characteristics listed in table I. If the null hypothesis is true, then the bivariate Mann-Whitney statistic tends to be chi-square distributed as the sample size increases. We assume that the chi-square table can be used in our case.

The value of the Mann-Whitney statistic calculated from the measures of improvement on the involved side for the control and the exercise groups is 0. 194. For the null hypothesis to be rejected at the 5 per cent level of significance the statistic would have to be at least 4.6, and at the 10 per cent level, at least 3.2. Further, if the null hypothesis were true, then it would be expected that about 95 per cent of the observed samples would yield a statistic at least as large as 0.194. On this basis, we do not reject the hypothesis that there is "no difference" between the control and the exercise groups in response to two different programs of treatment.

To check for the consistency of this conclusion, the familiar T^2 statistic was calculated for the data. This statistic is only strictly valid for testing for equality of means for data with a bivariate normal distribution. The value obtained was 0.54. To reject the hypothesis of "no difference" in the means of the scores for the control and exercise groups at the 5 per cent level, this statistic would have to be at least as large as 4.68. This analysis, then, is consistent with the previous one.

In using the Mann-Whitney statistic, the question arises whether the null hypothesis can be accepted when the alternative is true.

This question cannot be answered directly, but some experimentation indicates that if, in fact, the values for the scores for each patient in the exercise group were 2 to 3 times greater than those for the control group, the hypothesis of ' 'no difference" would be rejected at the 10 per cent significance level. From the medical standpoint, one might expect that an effective therapeutic exercise regimen would make at least this degree of difference in the patient's performance. This is particularly true since the scores under discussion are small in comparison with the variability of scores for an unimpaired population. We believe that the statistical methods used are powerful enough to detect differences which could be considered medically significant.

Appendix

The following treatment schedules were designed by Jeffery laccobucci, R.P.T. (now third-year medical student), Barbara Amen, B.A., R. P.T. (Director, Physical Therapy Department, The Burke Rehabilitation Center), Anthony DeRosa, M.A., R.P.T. (Co-ordinator, Rehabilitation and Education Service, The Burke Rehabilitation Center) in cooperation with the physical therapy staff of The Burke Rehabilitation Center and Other institutions. Treatment schedules were controlled and carried out by a physical therapist.

GROUP A (CONTROL GROUP)

Heat or at times cold modalities were used to alleviate pain in the affected shoulder or arm. Passive range of motion was carried out in all extremities. Braces and/or splints were removed. Treatment time for modalities: 20 minutes. For passive range of motion: maximal 15 minutes.

Ambulation: Temporary or permanent bracing was used when indicated. Severely

paretic patients stood in the parallel bars, balanced, and if possible, walked three times the length of 20-ft. bars and back with assistance. Moderately paretic patients used walkerette and walked with assistance in the gym, covering a distance of not more than 420 ft. Mildly paretic patients used a regular cane and covered a distance of not more than 420 ft. They used stairs, curb and ramp once, with assistance, if necessary. Time allowance for formal gait training did not exceed 40 minutes.

GROUP B (EXERCISE GROUP)

Thermal modalities, passive ranges of motion, and ambulation were carried out in the same manner as for Group A. In addition, therapeutic exercises were carried out for a period of at least 40 minutes. These exercises were based on proprioceptive neuromuscular facilitation as described by Knott and Voss and on the techniques described by Brunnstrom. Depending on the patient's motor ability, exercises were performed assistively when needed, or against progressive resistance when tolerated. Maximal effort was encouraged in each procedure, and repetitions were limited to 10 for each exercise. The following are examples of the techniques employed by the physical therapists:

Upper Extremity and Trunk

(1) Starting position, sitting: use of flexion and extension synergies elicited by offering resistance to the uninvolved side.

(2) Starting position, supine: with the elbow flexed, shoulder extended, wrist and fingers flexed and forearm supinated, the patient pushes straight up thus flexing the shoulder, extending the elbow, wrist, and fingers, and pronating the forearm. In returning to starting position extend shoulder, flex elbow, wrist, fingers and supinate forearm.

Starting position sitting or supine: Start with shoulder extended, abducted, internally rotated, and the elbow extended. The patient flexes, adducts, and externally rotates the shoulder while the elbow remains extended. In returning, the opposite is performed, keeping elbow extended.

Starting position, sitting: Rotate the trunk to the right to facilitate retraction or the shoulder and adduction of scapula. The head is turned to the right also. This exercise is to be performed on both sides.

Starting position, supine: Both knees are flexed and adducted. Patient swings them from one side of the mat to the other so that at one time the lateral side of the right thigh touches the mat, then the lateral side of the left thigh touches the mat, keeping both knees together throughout.

Lower Extremity

(1) Starting position, supine: Patient's uninvolved hip is flexed with the knee bent. Involved leg is extended (Thomas test), He is then encouraged to flex the involved hip.

Starting position, supine: Both legs are extended and raised 6 inches or so from the table by placing a pillow under the patient's heels or a therapist supports them. The patient then pushes his heels downward thus raising legs, buttocks, and low back from the table.

Starting position, supine: Hip flexion and extension synergies to include trunk rotation with knees either flexed or extended and ankles dorsiflexed. Starting with the involved leg over the edge of the table, hips extended, knees either flexed or extended and ankle plantar flexed. As patient flexes hip, he rotates his trunk to the opposite side and dorsiflexes his ankle. In returning to the starting position, the opposite movement occurs.

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