

Research in the Clinical Application of Forced Use
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Purpose: To investigate the potential for a clinical model using a forced use paradigm for Clients with limited to severe motor impairments in the upper extremity. The subjects ranged from those having no movement proximally and distally to those with only proximal motor control and little or no movement distally.

Design: Group I: The clients with severe motor impairments were engaged in forced use strategies for six weeks, six hours per day, four days per week. On the fifth day the clients were involved in community outings in constraint. The clients were also required to do one to two hours of homework each evening including weekends.

Group II: the clients with limited motor impairments were engaged in forced use strategies for four weeks, six hours per day, four days per week. On the fifth day the clients were involved in community outings in constraint. These clients were also required to do one to two hours of homework each evening including weekends.

Setting: A house in West Los Angeles, California. This setting was selected because it afforded the clients a functional environment.

Participants: Group I: There were five clients in the group. Four clients completed the program. One client had to withdraw after two weeks because of a family illness. In Group II: There were five clients in the group- the entire group completed the four weeks.

The Research Team: Six physical therapists composed the research team.

Intervention: Group I: The clients received treatment by a physical therapist for one and a half hours per day, Monday through Thursday during the first three weeks and two hours daily, Monday through Thursday for the remaining weeks three weeks. In addition each client received feedback from the physical therapist in the form of manual guidance during lunch while in constraint. The clients were involved in Massed Practice in constraint for 2.5 hours and in bilateral activities out of constraint for 1.5 hours per day four days each week. In each of these types of massed practice they received both verbal and manual feedback from the physical therapist.

Group II: The clients were handled in treatment by a physical therapist for one and a half hours per day for the first two weeks and they received no treatment in weeks three and four. In addition they received manual feedback during lunch in constraint. The clients were involved in Massed Practice in constraint and in bilateral activities out

of constraint for four hours a day for the first two weeks four days per week. In weeks three and four this was increased to four hours in Constraint and one and a half hours of Bilateral Massed Practice activities without Constraint per day.

Outcome Measures: The clients in both groups were engaged in self-monitoring using the MAL on a daily basis for the entire length of the study. The clients in Group I were evaluated using the Modified Wolf Motor Function Test three times over the six-week period. The clients in Group II were evaluated using the Modified WMFT two times over the four-week period. The Massed Practice was measured by “number of repetitions” over time. The clients in Group II were also interviewed individually concerning their perceptions of the experience and the learning process. Four of the Physical therapists were also interviewed concerning their perceptions of the experience.

Results: The results do not statistically reflect the changes in motor function that the clients in group 1 achieved. Due to the severity of motor dysfunction in these clients there was no statistically significant change in motor function. This result was directly related to the inadequacy of the motor assessment evaluation scale for measuring changes in clients with profound movement dysfunction. The existing measurement scale does not reflect the

difference between proximal and distal improvements in motor recovery. The measurement tool however is designed for clients who have the capability of completing the task with the involved arm. The grading scale is therefore contingent upon the completion of the task. The existing measurement tool is as a result not designed for clients with more severe deficits. In Group 2 all of the clients showed statistically significant improvement due to the fact that all of the clients had gross proximal motor function prior to beginning the project and needed to coordinate this movement with recovery of motor function in the forearm and hand.

Conclusions: Though it is obvious from the results that a more appropriate measurement tool needs to be developed for clients having more severe motor dysfunction. The following changes occurred in both groups: In Group I the transport phase of reach was achieved by all of the clients with one exception. Three of the clients in Group I were able to achieve gross grasp and release with some objects in the WMFT but this was not consistent and appeared unrelated to size or shape of the object. In Group II all of the clients regained the ability to coordinate the transport phase of reach with the grasping and manipulating of objects.

Introduction:

Currently the statistics regarding the percentage of clients with Hemiplegia that recover upper extremity function to the point that the affected hand/arm can be used in a unilateral way to reach for and manipulate objects is very low in the realm of 30%. This type of statistic is a reminder of why such a small percent of clients with Hemiplegia return to the workforce, even though a large number of clients with Hemiplegia are below the age of retirement. The experience of these researchers over the last 25 years is that most clients remain motivated to regain use of the arm but do not perceive this as an attainable goal. Most therapists believe that, though they are aware of the desires of the client regarding upper extremity function, they are unable to effect the acquisition of this function employing current management strategies.

The primary aim of this project was to explore the potential for creating a clinical model for reinstating upper extremity function in the population of clients having more severe impairments in the arm resulting from C.V.A.

The Therapeutic Model

The therapeutic model utilized for this project was the result of a melding of the researchers' clinical experience in creating handling strategies designed to optimize the client's ability to achieve muscle activation in practice conditions having a very high level of intensity. These

management strategies were carried out promoting the activation of skeletal muscle in the closed chain and involved graded force in both the agonistic and antagonistic muscle groups for improved strength, endurance and coordination. These strategies were carried out within the framework of handling sessions having a duration of one and one half hours. The session included activities that were labeled by the researchers Forced Use Handling Strategies. The handling sessions also included orthopedic management of stiffness in connective tissue causing limitations in range of motion thus preventing voluntary movement through the ranges required in function. The consequent resistance to movement results in the clients' selection of alternative movement patterns from those regarded as optimal and in many cases disallows movement completely. Following the handling session each client was afforded a thirty-minute break followed by massed practice with the less involved upper extremity in constraint. Each activity in constraint was carried out for periods of time no less than 40 minutes in duration. In the beginning the activities selected for massed practice were directed toward improving the clients ability to actively move the humerus away from the body and to coordinate the humeral elevation with elbow extension. All of the activities were carried out with intermittent manual feedback from the research assistant helping the client. The morning block of massed practice was 1.5 hours long followed by lunch.

The meal was eaten using the involved arm, in most cases with the less involved upper extremity constrained on the arm rest of the chair in which the client was sitting. Manual as well as verbal feedback was given throughout the entire meal. Following lunch there was a 30-minute rest period following lunch. The afternoon session consisted of 1.5 hours of unilateral massed practice in constraint followed by one hour of bilateral massed practice. The bilateral massed practice also involved manual and verbal feedback administered by the therapists.

At the beginning of each day the client and his/her research assistant discussed the outcome of the homework assigned to the client did for the prior evening. Part 1 of the MAL was administered each day of the week with the exception of Friday. On Friday the entire MAL was administered.

On Friday the researchers elected to use an alternative plan in which the entire group of clients participated in a community outing. On the outings the clients were required to wear the constraint, or participated in an activity that could only be successful using both upper extremities. Some of the activities included a car wash, tricycle riding on Santa Monica Beach, salsa dancing and grocery shopping.

The modified Wolf Motor Function test was used as a measuring tool for the acquisition of skill in the upper extremity for these severely involved clients. The test was given to each Client prior to beginning the project, after three weeks had passed and then at the end of this six-week project.

Aim of the Handling session:

The aim of the handling session was to prepare the client to participant in activities using the involved upper extremity segment. This involved mobilizing the structures that would cause malalignments in the scapula and make stability in the scapula difficult. Necessary also was strengthening of the musculature required for stabilizing the scapula and activating, strengthening and coordinating the segments of the arm and hand. The handling session was also used to eliminate movement dysfunction in other body segments that negatively impact the use of the involved upper extremity segment. Since more than 80% of upper extremity function is carried out while standing and walking control of the lower extremities including the strengthening of the hip on the involved side was an important goal of the handling session.



Massed Practice in Constraint:

As a handling strategy massed practice is the repetition of a pattern of movement in order to strengthen the clients ability to access that pattern more automatically as required in any function. At the outset it is not deemed important that the parameters of the movement pattern selected by the client is perfect. As well it is not important that the client select the correct force parameters for the specific pattern of movement being practiced. The first requirement of the practice is that the activity can be completed at some level. As applied in this project, the clients were given manual and verbal feedback intermittently in order to allow the client to be successful in the task. The amount of feedback was progressively reduced, as the client was more capable of completing the task. The activities were made progressively more difficult as the client achieved improved speed and efficiency. In all cases it was observed that the movement and force parameters became more correct with practice.

Considering the level of motor control that the clients in Group I possessed at the beginning of the project the massed practice was first limited to proximal movement of the humerus away from the body. The hand was placed and maintained on the object to be moved. The activities

were therefore all done in the closed chain and the client was not required to transport the to the object. An example of this type of activity was pushing the grocery cart. The hand was placed on the handle and the client was asked to push the cart away from and back to his body. Another similar closed chain activity involved tilting the stepladder. These activities enabled the client to achieve the transport phase of reach while still working in the closed chain. The activities also helped the client with endurance and muscle strengthening because the client engaged in each activity for 30-50 minute periods of time. Each of the objects moved could be made progressively heavier by adding weight. The clients in Group 2 were able to transport their arms to the objects but required assistance manually and verbally in shaping the hand for the object. This group also engaged in open chain activities in massed practice like grasping and moving silverware and stacking blocks.

Massed Practice In Constraint

The conditions for Massed Practice afforded the clients the opportunity, through the practice and repetition of movement patterns in each activity, to make movement selections more within the normal spatial, temporal, and force parameters in reaching, grasping and manipulating objects. Due to the functional limitations of the clients in this study the completion of the activities in massed practice could only be achieved through verbal and

manual feedback from the therapist. Feedback was administered intermittently and the frequency of feedback was progressively reduced as the client became more capable of completing the activity independently. The amount of error and variability in movement was much greater in Group 1 than in Group 2 making it easier to “Fade” feedback in Group 2. In both groups the level of difficulty was progressively increased as the client became more successful in completing the activities of massed practice.





Bilateral Massed Practice:

These types of activity were included in the project to reinstate interscapular coordination and reintegrate both arms into activities requiring bilateral use of the upper extremities. This resulted in the clients ability to monitor the tendency of choosing too much force in the less involved upper extremity, and also assisted the clients in selecting more appropriate spatial, temporal, and force parameters in the movement patterns practiced. These activities were found to be very motivating to the clients

since they were often oriented toward functions in which they had been unable to engage since the onset of the stroke or head injury. Some examples of this type of activity were hammering nails, and lifting and manipulating laundry baskets and ironing board or laundry basket.

Testing Procedures:

MAL (Motor Activity Log): The first fifteen questions were discussed with the client on the first four days of each week and on the fifth day the entire thirty questions were presented and discussed with each client.

WMFT (Wolf Modified Motor Function Test): A modified version of the WMFT was given to the clients in Group 1 three times over a six-week period. The clients in Group 2 were given this test twice over the four weeks. Thirteen items were selected to be used for the evaluation of motor function in both groups of clients. There were some changes made in the wording of measurement scales in order to make more of a distinction between the quantity and quality of movement.

Test Results: It is clear from the results listed that there was no statistical change of one standard deviation in either group. The n /number of clients in the sample was very limited which of course also bias's the result. The result in Group 1 as well as in Group 2 does not

adequately reflect the incredible change that occurred in the parameters of aim reach and grasp that would ultimately lead to success in tasks. What is of more interest is that there was more statistical improvement in tasks that involved gross use of the arm rather than tasks of selective hand function type.

Table 1. Agreement Among Researchers and Independent Evaluators on Assessment of **Functional Ability**.

Activity	Kendal Tau (τ)	Significance
Hand on Table (front)	.509	0.096
Hand on Box (front)	.851	0.000
Hand on Table (side)	.786	0.001
Hand on Box (side)	.709	0.014
Elbow Extension	.820	0.000
Elbow Extension (weight)	.858	0.000
Weight on Arm	.608	0.015
Get cloth and wipe water	.723	0.007
Release Cloth	.758	0.000
Grasp Bottle/Place on Box	.767	0.000
Grasp Bread & Take Bite	.518	0.045
Grasp wine glass & Bring to Mouth	.806	0.000
Grasp spoon & Bring Cereal to Mouth	.644	0.019
Grasp hair brush & Brush hair	.815	0.000
Turn knob & open and close door	.773	0.000
Turn Light on and off	.799	0.000
Button Jacket	.495	0.117

Table 2. Agreement Among Researchers and Independent Evaluators on Assessment of **Movement Quality**

Activity	Kendal Tau (τ)	Significance
Hand on Table (front)	.838	0.000
Hand on Box (front)	.756	0.009
Hand on Table (side)	.798	0.006
Hand on Box (side)	.737	0.000
Elbow Extension	.899	0.000
Elbow Extension (weight)	.858	0.000
Weight on Arm	.822	0.000
Get cloth and wipe water	.840	0.000
Release Cloth	.885	0.000
Grasp Bottle/Place on Box	.893	0.000
Grasp Bread & Take Bite	.792	0.000
Grasp wine glass & Bring to Mouth	.817	0.000
Grasp spoon & Bring Cereal to Mouth	.682	0.000

Grasp hair brush & Brush hair	.737	0.000
Turn knob & open and close door	.759	0.000
Turn Light on and off	.767	0.000
Button Jacket	.592	0.003

Table 3. Comparison of Pretest-Mid-Posttest Functional Ability Scores (Group I)

Activity	Pretest Mean Rank	Midtest Mean Rank	Posttest Mean Rank	Friedman (χ^2)	Significance
Hand on Table (front)	1.75	2.13	2.13	2.000	0.368
Hand on Box (front)	1.25	2.38	2.38	6.000	0.050
Hand on Table (side)	1.75	2.13	2.13	2.000	0.368
Hand on Box (side)	1.63	2.38	2.00	2.000	0.368
Elbow Extension	1.63	2.00	2.38	3.000	0.223
Elbow Extension (weight)	2.13	1.50	2.38	2.600	0.273
Weight on Arm	1.88	1.88	2.25	1.000	0.607
Get cloth and wipe water	1.50	2.25	2.25	4.000	0.135
Release Cloth	1.50	2.13	2.38	2.600	0.273
Grasp Bottle/Place on Box	1.38	2.13	2.50	4.667	0.097
Grasp Bread & Take Bite	1.25	2.38	2.38	6.000	0.050
Grasp wine glass & Bring to Mouth	1.13	2.50	2.38	5.692	0.058
Grasp spoon & Bring Cereal to Mouth	1.25	2.38	2.38	6.000	0.050
Grasp hair brush & Brush hair	1.25	2.50	2.25	5.600	0.061
Turn knob & open and close door	1.88	2.25	1.88	0.667	0.717
Turn Light on and off	1.88	1.88	2.25	2.000	0.368
Button Jacket	1.63	2.00	2.38	3.000	0.223

Table 4. Comparison of Pretest-Mid-Posttest Movement Quality Scores (Group I)

Activity	Score Pretest	Score Mid	Score Posttest	Friedman (χ^2)	Significance
Hand on Table (front)	1.38	2.50	2.13	4.667	0.097
Hand on Box (front)	1.63	2.38	2.00	3.000	0.223
Hand on Table (side)	1.88	1.88	2.25	2.000	0.368
Hand on Box (side)	1.75	2.13	2.13	2.000	0.368
Elbow Extension	2.13	1.63	2.25	1.400	0.497
Elbow Extension (weight)				2.000	0.368
Weight on Arm	1.63	1.63	2.75	4.500	0.105
Get cloth and wipe water	1.38	2.13	2.50	4.667	0.097
Release Cloth	1.50	2.25	2.25	2.667	0.264
Grasp Bottle/Place on Box	1.50	2.25	2.25	2.667	0.264
Grasp Bread & Take Bite	1.63	2.00	2.38	3.000	0.223
Grasp wine glass & Bring to Mouth	1.75	1.75	2.50	4.000	0.135
Grasp spoon & Bring Cereal to Mouth	1.88	1.75	2.38	1.400	0.497
Grasp hair brush & Brush hair	1.88	2.25	1.88	2.000	0.368
Turn knob & open and close door	1.88	1.75	2.38	1.400	0.497
Turn Light on and off	1.63	2.38	2.00	3.000	0.223
Button Jacket	2.00	1.63	2.38	1.500	0.472

Table 5. Comparison of Pretest-Posttest Functional Ability Scores (Group II)

Activity	Score Pretest	Score Posttest	Z Wilcoxon Signed Rank	Significance
Hand on Table (front)	4	4	-1.000	0.317
Hand on Box (front)	4	4	-1.000	0.317
Hand on Table (side)	4	4	-0.557	0.564
Hand on Box (side)	4	4	-1.000	0.317
Elbow Extension	3	4	-0.447	0.655
Elbow Extension (weight)	3	4	-0.447	0.655
Weight on Arm	4	5	-1.732	0.083
Get cloth and wipe water	4	4	-0.378	0.705
Release Cloth	4	4	-0.447	0.655
Grasp Bottle/Place on Box	4	4	-1.414	0.157
Grasp Bread & Take Bite	4	2	-1.732	0.083
Grasp wine glass & Bring to Mouth	3	4	-2.236	0.025
Grasp spoon & Bring Cereal to Mouth	3	4	-1.342	0.180
Grasp hair brush & Brush hair	4	4	-1.000	0.317
Turn knob & open and close door	4	5	-2.000	0.046
Turn Light on and off	4	4	-1.732	0.083
Button Jacket	3	3	-0.577	0.564

Table 6. Comparison of Pretest-Posttest Movement Quality Scores (Group II)

Activity	Score Pretest	Score Posttest	Z Wilcoxon Signed Rank	Significance
Hand on Table (front)	3	3	-1.000	0.317
Hand on Box (front)	3	3	-1.000	0.317
Hand on Table (side)	3	3	-1.000	0.317
Hand on Box (side)	4	4	-0.557	0.564
Elbow Extension	3	4	-1.732	0.083
Elbow Extension (weight)	3	4	-1.000	0.317
Weight on Arm	3	5	-2.000	0.046
Get cloth and wipe water	3	3	-1.414	0.157
Release Cloth	3	4	-1.633	0.102
Grasp Bottle/Place on Box	4	4	-1.000	0.317
Grasp Bread & Take Bite	4	4	0.000	1.000
Grasp wine glass & Bring to Mouth	3	4	-1.414	0.157
Grasp spoon & Bring Cereal to Mouth	3	4	-1.000	0.317
Grasp hair brush & Brush hair	4	3	-1.000	0.317
Turn knob & open and close door	4	1	-1.000	0.317
Turn Light on and off	4	4	-1.000	0.317
Button Jacket	3	3	-1.633	0.102

Summary:

In summary it is imperative that each group of clients be discussed separately since the functional abilities were at different levels in terms of motor control in the Upper Extremity. In conclusion some general comments regarding both groups of clients will be discussed.

There were very significant changes in motor function in both groups of clients in the study. In addition to the WMFT as a primary measurement tool, there was a substantial amount of video documentation in this project. Video documentation was extensively utilized as a means of documenting the Massed Practice sessions, the treatment sessions, lunch and the outings on Friday. These are activities for which there is no existing measurement tool. In the case of bilateral upper extremity function there is no appropriate evaluation scale. It is hypothesized by these researchers that this area of motor control is critical as a practice condition for the reintegration of the two arms in activities requiring bilateral use of the upper extremities in daily activities. The inclusion of bilateral activities in this study appeared to result in a higher frequency of actual use of the involved arm in the times when the clients were in their living

environment outside of the study.

The clients in Group 1 required more management orthopedically due to the Biomechanical constraints related to connective tissue “stiffness.” They also required more handling in treatment to reduce hypertonicity as a preparation for massed practice, and in massed practice more feedback for “shaping” of the movement patterns practiced. The most significant gains in motor control occurred during the Fourth week indicating that more practice and repetition may be necessary the clients having more severe motor impairments. In massed practice it is imperative that the emphasis is on the achievement of the transport phase of reach prior to the shaping of the hand for the object and the manipulation of the object. It is also obvious that a more appropriate measurement tool be created for these clients; one that will actually reflect the improvements in motor functioning which occurred in this group.

Group 2: All of the clients made measurable changes in motor control. This group of clients all achieved better intrinsic hand function for grasping and manipulating objects and did not require as much management orthopedically or for the reduction of hypertonicity as in Group 1. These differences made it possible to eliminate treatment during weeks 3 and 4, providing much more

time for massed practice. The major improvements in this group occurred in the third week and progressively more in the fourth week.

General Comments:

A new measurement tool needs to be developed for documentation of the changes that occur in Upper Extremity function in regard to the components of Aim, Reach and Grasp. In motor control studies these parameters have been described. Transporting the hand to the object (reaching) is characteristically a more ballistic movement, followed by a “fine adjustment phase” for the shaping of the hand for the object. The achievement of these components by the clients, particularly in Group 1, could not be documented since in most cases the client could not complete the activity through graded grasp and manipulation of the objects.

The criteria for inclusion in the current research such as the EXCITE project that being conducted in the USA excludes all of the clients in Group 1. Also three of the clients in Group 2 did not meet the criteria in regard to distal movement in the wrist and the hand intrinsically. The present evaluation scale is not sensitive to the significant changes that the clients in Group 1 made in attaining the

transport phase of the hand to the object and the shaping of the hand . The changes in the ability to coordinate the shoulder, elbow and forearm in bringing the hand to the objects was not measurable. A more appropriate tool should be developed and utilized to reevaluate the clients in Group 1. It is our belief that this model brings results in significant but as yet undocumented progress in the recovery of motor control in clients who are incapable of moving their arm.

It was observed that both groups improved significantly in the use of the involved hand and arm for eating. Feedback during these activities was significantly or completely withdrawn in this function although some of the clients needed to arrange their own hand on the utensil while others could acquire the utensil.

The use of the MAL on a daily basis was found to be extremely helpful and positive. The daily discussion of the different activities in which the arm could attempt to use the involved arm appeared to motivate the client in making more constant attempts to use the arm in function. The knowledge that there would be a discussion of regarding the attempts to use the arm in specific activities held the client more accountable for the use of the arm in function.

The research team felt that the outings in the community on Friday helped not only with the client's willingness to utilize the arm functionally in a more social context but in addition with the emotional bonding in each of the groups. These activities raised the morale level and motivation in each of the clients and also helped in lowering the stress level imposed by the intensity of treatment and massed practice on the preceding four days (Monday-Thursday). During the treatment and massed practice sessions it was also observed that there was a benefit when 4-5 clients working together in a common space. Each time a client achieved success in a new motor function the whole group was vocally supportive and this was a great source of motivation among the clients.

During the final week of the project an independent professional interviewed the clients and the research team. Each client and therapist was questioned regarding his or her perceptions of the experience and participation in this study. The duration of interview was one to one and one half hours and was documented on Audio Tape. It is the intention of the researchers to present this information in the form of a paper at a later date.

The clients and therapists who participated in this project are greatly appreciative of this experience and the enrichment it brought to all of our lives! The psychological

benefits of this project served to enhance the physical progress made by each of the clients. To this end we give our total thanks to the ...Foundation who sponsored this project.



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