AOTA Critically Appraised Papers Series

Evidence Exchange

**A product of the American Occupational Therapy Association's Evidence-Based Literature Review Project*

CRITICALLY APPRAISED PAPER (CAP)

FOCUSED QUESTION

For stroke patients, in what ways does robot-assisted therapy improve upper extremity performance in the areas of motor impairment, muscle power, and strength?

Yang, C., Lin, K., Chen, H., Wu, C., & Chen, C. (2012). Pilot comparative study of unilateral and bilateral robot-assisted training on upper-extremity performance in patients with stroke. *American Journal of Occupational Therapy, 66,* 198–206.
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CLINICAL BOTTOM LINE:

Stroke is the leading cause of long-term disability among adults. Adequate rehabilitation of the upper extremity in stroke patients can improve performance in activities of daily living. Robot-assisted therapy can offer intense, repetitive, and task-specific training to the impaired limb after stroke. Prior studies have shown that robot-assisted therapy may improve strength and motor deficits of the impaired limbs, but there is a lack of research comparing the effects of unilateral robot-assisted training protocol (URTP) versus bilateral robot-assisted training protocol (BRTP) with a robotic device. Comparison of the effectiveness of these two protocols is beneficial to determine the appropriate treatment choice for individual patients. This study used a robotic device called the Bi-Manu-Track to determine the effectiveness of both unilateral and bilateral robotic therapy protocols on motor impairment, muscle power, and muscle strength.

The population for this study was adults who had had single or repetitive unilateral cerebral strokes resulting in hemiparesis. The intervention included exercises in forearm pronation and supination, as well as wrist flexion and extension, with the Bi-Manu-Track robotic device. Three therapy groups were compared: unilateral robotic therapy, bilateral robotic therapy, and a control group that received routine occupational therapy. All training sessions were conducted by trained occupational therapists, and participants in all three groups received 90–105 min of training per day, 5 days per week, for a total of 4 weeks.

The researchers of this study found that the URTP and BRTP groups had greater improvements in motor impairment, muscle power, and strength than did the control group. The URTP seemed to be more effective in improving motor impairment and muscle power at the distal joints than the other two groups. Conversely, the BRTP brought about greater improvement in muscle power at the proximal joints than did the URTP and traditional occupational therapy. All participants in the study improved on grip strength, with no statistically significant differences among the three groups. Overall, robotic-assisted training protocols can provide the intensive repetitive movements and task-specific interventions that are needed for upper extremity rehabilitation poststroke. On the basis of the results of this study, both URTP and BRTP can be effective interventions in upper extremity rehabilitation for patients after stroke. The results of this study show different outcomes in motor impairment, motor power, and strength for unilateral versus bilateral training protocols. Therapists using the Bi-Manu-Track are advised to select the specific protocol that will target improvement for their patients. More studies should be conducted with a larger sample size to further fill in the gaps of knowledge about robot-assisted training for individualized therapy.

RESEARCH OBJECTIVES

List study objectives.

To determine whether unilateral and bilateral approaches of the Bi-Manu-Track, a commercially available end-effector robotic device, can improve motor abilities in the areas of motor impairment, muscle power, and strength, as opposed to the traditional occupational therapy activities (control group). Also to compare the differences of outcomes between the unilateral and bilateral training protocols using the Bi-Manu-Track.

DESIGN TYPE AND LEVEL OF EVIDENCE:

Level I: Randomized pretest–posttest design

SAMPLE SELECTION

H**ow were subjects recruited and selected to participate? Please describe.**

The participants were recruited from five unspecified hospitals. One hundred eighteen participants were assessed for eligibility. In all, 97 of the assessed participants were excluded, 77 of these because they did not meet inclusion criteria. After the remaining 21 participants were enrolled in the study, they were randomized into one of the three groups: URTP (n = 7), BRTP (n = 7), and control treatment (n = 7).

Inclusion Criteria

The criteria for inclusion in the study were as follows: first or recurrent clinically diagnosed unilateral cerebral stroke, resulting in hemiparesis, within the past 6 months to 5 years; ability to reach Brunnstrom Stage III and above; spasticity in any of the joints (shoulder, elbow, wrist, fingers) of the impaired arm of ≤2 on the Modified Ashworth Scale; score of ≥22 on the Mini-Mental State Examination; and a Fugl–Meyer Assessment (FMA-UE) score of >1 on any item.

Exclusion Criteria

Participants could not have any other neurological, neuromuscular, or orthopedic diseases and must not have participated in any experimental rehabilitation or drug studies in the previous 3 months.

SAMPLE CHARACTERISTICS

N = **(Number of participants taking part in the study)**	21

#/% Male	14/66.7%		#/% Female	7/33.3%

Ethnicity	N/A

Disease/disability diagnosis	Unilateral cerebral stroke

INTERVENTION AND CONTROL GROUPS

Add groups if necessary

Group 1: BRTP of upper extremities

Brief description of the intervention	Each participant used both upper extremities to practice repetitions of Modes 1, 2, and 3 of the Bi-Manu-Track robotic device. The movement patterns were forearm pronation and supination, and wrist flexion and extension. In Mode 1 (passive–passive), both arms were moved passively by the machine. In Mode 2 (active–passive), the impaired arm was guided by the unimpaired arm in a symmetric direction. In Mode 3 (active–active), the unimpaired arm overcame continual resistance through the whole movement, and the impaired arm overcame only the initial resistance. The resistance was adjusted individually according to the maximal force of the participant's active movement. Each participant practiced

	300–400 repetitions in Modes 1 and 2 and 50–80 repetitions in Mode 3. Each session included 75–80 min of robot-assisted training, followed by 15–20 min of functional task practice, such as reaching for a cup, grasping and releasing blocks, picking up coins, wiping a table with two hands, picking up two pegs, and opening a jar with one hand stabilizing while the other hand manipulated.
How many participants in the group?	7
Where did the intervention take place?	Five hospitals (unspecified) during occupational therapy sessions
Who delivered?	Certified occupational therapist trained to administer BRTP
How often?	5 days a week, 90–105 min
For how long?	4 weeks

Group 2: URTP of upper extremity

Brief description of the intervention	Participants in the URTP intervention group practiced with only the impaired arm. The repetitive movements; level of repetitions in Modes 1, 2, and 3; and level of resistance in Mode 3 were applied as in the BRTP group. The participants also practiced 15–20 min of functional tasks, as in the BRTP group.
How many participants in the group?	7
Where did the intervention take place?	Five participating hospitals (unspecified) during occupational therapy sessions
Who delivered?	Certified occupational therapist trained to administer URTP
How often?	5 days/week, 90–105 min
For how long?	4 weeks

Group 3: Control

Brief description of the intervention	Therapeutic activities in the control group were designed with a similar duration and intensity as in the BRPT and URPT groups. The activities performed by the control group included weight bearing, stretching, strengthening of the impaired arm, coordination activities, unilateral and bilateral fine motor tasks, and balance tasks.
How many participants in the group?	7
Where did the intervention take place?	Five participating hospitals (unspecified) during occupational therapy sessions.
Who delivered?	Certified occupational therapist trained to administer the control treatment
How often?	5 days/week, 90–105 min
For how long?	4 weeks

Intervention Biases

Check yes, no, or NR, and explain, if needed.

Contamination:

YES ☐ NO ☒ NR ☐	*Comment:*

Cointervention:

YES ☒ NO ☐ NR ☐	*Comment:* Although participants involved in the study did not receive other occupational therapy interventions, they might have received routine interdisciplinary stroke rehabilitation, including physical therapy and speech therapy. The physical therapy interventions that involved upper-extremity training might have contributed to the changes in upper-limb motor function.

Timing:

YES ☐ NO ☒ NR ☐	*Comment:*

Site:

YES ☒ NO ☐ NR ☐	*Comment:* The study took place in five different unidentified hospitals, which might have caused site bias.

Use of different therapists to provide intervention

YES ☒ NO ☐ NR ☐	*Comment:* Five certified therapists were trained to administer the URTP, BRTP, and control treatment protocols at the five participating hospitals.

MEASURES AND OUTCOMES

Complete for each measure relevant to occupational therapy.

Measure 1

Name/type of measure used:	Fugl–Meyer Assessment (FMA-UE)
What outcome is measured?	Motor impairment of the shoulder, elbow, forearm, wrist, and hand. Proximal: shoulder, elbow, and forearm Distal: wrist and hand
Is the measure reliable?	YES ☐ NO ☐ NR ☒
Is the measure valid?	YES ☐ NO ☐ NR ☒
When is the measure used?	Pretest–posttest, before and after the 4-week intervention period.

Measure 2

Name/type of measure used:	Medical Research Council instrument (MRC)
What outcome is measured?	Muscle power of the proximal and distal muscles of the upper extremities (proximal: shoulder flexors, shoulder abductors, elbow flexors, elbow extensors; distal: wrist flexors, wrist extensors, finger flexors, and finger extensors)
Is the measure reliable?	YES ☐ NO ☐ NR ☒

Is the measure valid?	YES ☐ NO ☐ NR ☒
When is the measure used?	Pretest–posttest, before and after the 4-week intervention period.

Measure 3

Name/type of measure used:	Jamar Dynamometer
What outcome is measured?	Grip strength of the hand
Is the measure reliable?	YES ☐ NO ☐ NR ☒
Is the measure valid?	YES ☐ NO ☐ NR ☒
When is the measure used?	Pretest–posttest, before and after the 4-week intervention period

Measurement Biases

Were the evaluators blind to treatment status? *Check yes, no, or NR, and if **no**, explain*.

YES ☒ NO ☐ NR ☐	*Comment:*

Was there recall or memory bias? *Check yes, no, or NR, and if **yes**, explain*.

YES ☐ NO ☒ NR ☐	*Comment:*

RESULTS

List key findings based on study objectives. Include statistical significance where appropriate ($p < .05$). Include effect size if reported.

A large effect is represented by r > .5, a moderate effect by r > .3, and a small effect by r > .1. Level of statistical significance was set at .05. Because the mean scores of the dependent variables did not fully coincide with the hypotheses, the authors conducted post hoc contrast analyses for the FMA-UE overall score, proximal part subscore, MRC

proximal and distal part subscores, and grip strength for the bilateral condition to assess further data. Post hoc contrast analysis showed that the URTP group improved on the FMA-UE overall score (r = .61, p < .01), proximal subscore (r = .70, p < .01), and the MRC distal part subscore (r = .48, p = .02) more than did the BRTP and control groups. Participants in the URTP group also improved in grip strength during the bilateral condition, but these improvements were not significantly greater than in the BRTP and control groups (p = .08). The BRTP group, however, did better than the control and URTP groups in terms of MRC proximal part subscore (r = .44, p = .03). The findings indicate that the URTP group showed better therapeutic effects in FMA-UE overall score and proximal part subscore and better muscle power at the distal joints than the BRTP and control groups. In addition, the BRTP group had greater improvement in muscle power at the proximal joints than the other two groups.

Was this study adequately powered (large enough to show a difference)? *Check yes, no, or NR, and if **no**, explain*.

YES ☐ NO ☒ NR ☐	*Comment:* The small sample size limited the power to detect statistically significant differences among the treatment groups. However, moderate to large effects were found for some dependent variables.

Were appropriate analytic methods used? *Check yes, no, or NR, and if **no**, explain*.

YES ☒ NO ☐ NR ☐	*Comment:*

Were statistics appropriately reported (in written or table format)? *Check yes or no, and if **no**, explain*.

YES ☒ NO ☐	*Comment:*

Was the percentage or number of participants who dropped out of the study reported?

YES ☐ NO ☒

Limitations

What are the overall study limitations?

One limitation is the small study size, with limited results to prove the significance of one treatment over the other. Another limitation is that the researchers did not study changes in motor control after intervention. The third limitation is a lack of occupation-based outcome measures, which would have allowed for information on functional changes after interventions. The study included a pretest and posttest evaluation but did not have a follow-up portion. A follow-up phase would have provided information about the long-term effects of robot-assisted therapy. A final limitation is that the majority of participants received physical therapy in conjunction with occupational therapy. Although physical therapy focused mainly on the participants' lower extremities, it cannot be ruled out that concurrent intervention in physical therapy influenced the overall improvement.

CONCLUSIONS

State the authors' conclusions related to the research objectives.

In conclusion, this study demonstrates that URTP with the Bi-Manu-Track device was the most favorable approach in improving motor impairment, distal muscle power, and grip strength. In contrast, BRTP was found to be more effective in increasing proximal muscle power. Furthermore, this research study has established the groundwork for further research on the use of robot-assisted intervention.

This work is based on the evidence-based literature review completed by Maria Mandrussow, OTS, Ani Keshishyan, OTS, and Kitsum Li, OTD, OTR/L, Faculty Advisor, Dominican University of California.