Circuit Training Following Stroke: A Literature Review

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Objectives

- Gain an understanding of motor control and motor learning principles
- Understand the strengths of circuit training literature
- Understand the limitations of circuit training literature
- Determine if circuit training is feasible in the subacute setting
- Gain an understanding on how you can implement circuit training into your PT practice

Motor Learning Principles: A Review

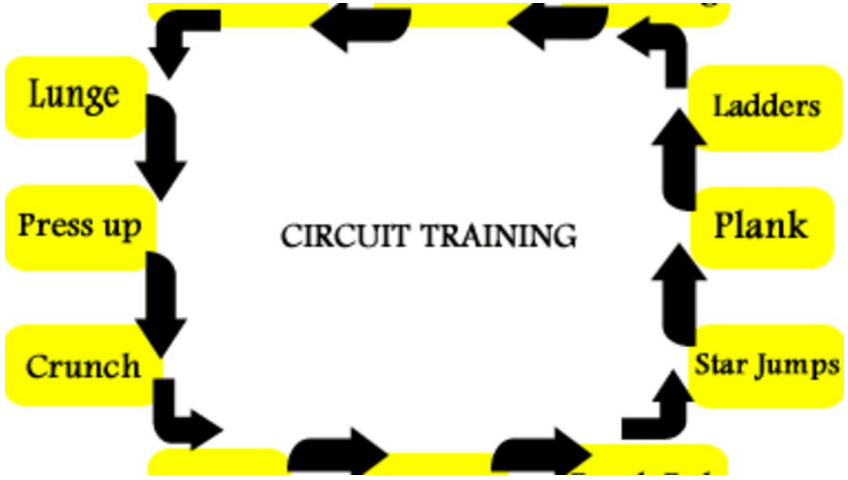
- High intensity, high repetitions has been shown to drive neuroplasticity - the brain's ability to modify, change, and adapt both structure and function throughout life and in response to experience
- Degree of performance improvement is dependent on the amount of practice
- Designing effective and challenging practice is key to fostering neuroplastic change
- Attention or “conscious” effort also improves learning

Are We Implementing Enough Practice?

- Unfortunately, no.
- 100s to 1000s of repetitions needs to be performed in order to promote neuroplasticity.
- One study found that there are only about 32 number of reps/session[1]
- On top of that, patients are only engaged in activity between 36-62 mins/day out of the 3 hours/day they are in therapy.[2-5]
- Limited therapy time requires practicing multiple functional tasks within that one session, not just focusing on one.

Circuit Training

- This mode of exercises combines multiple impairment-based and functional exercises.
- Typically, you are switching between tasks with short rest breaks to get to the next “station” or tasks
- Lots of latitude in how you put your circuit together
- This may provide the necessary method to encourage more task repetitions



Example of Circuit Training[6]

Roos et al, *Physical Therapy and Rehabilitation* 2021,
http://www.hoajonline.com/journals/pdf/2055-2386-8-6.pdf
doi: 10.7243/2055-2386-8-6

Table 1. Examples of Activities Included in the Functional Circuit Training Program (FCTP).

With activities:
1. Subjects were asked to perform slowly and then quickly. For some exercises, subjects were asked to hold the position
2. Subjects were given cognitive challenges that allowed movements to continue
3. Performed in standing position with no additional weight (some exceptions made for upper extremity movements, depending on participant ability)

Lower Extremity	Upper Extremity
Forward & sideways step-ups	Bottle, cup, mug (various weights) lifts to platforms
Forward & sideways step up & overs	Horizontal pulleys
Forward & sideways lunges	Reaching to cabinets
Squats	Block lifting
30 second Sit to Stand	Card matching
Hamstring curls	Zippering, buttoning, key turning activities
Heel raises	Figure tracing with laser light
Recumbent trainer	
Balance	**Cognitive**
Standing on trampoline/foam pad with & without upper extremity activity (ball/bean bag toss)	Counting
	Subtraction
Backward walking	Verbal Fluency tests
Forward & Backward Figure 8 walking	Naming words starting with letters of the alphabet
Forward & Backward tandem walking	Naming (based on individual interests)
Four Square Step Test/modified FSST	Dual Task (motor/motor; motor/cognitive)
Obstacle Course	Distinguishing objects of different colors (in areas of many objects)
	Memory games

Circuit Training and Chronic Stroke

- Overall: evidence shows improvement in patients >6 month following their stroke[6-8]
- Focus was on strength, balance, and locomotor deficits
- Pang et al[8] even included a target intensity during the task practice.
- Participants rotated through 3 stations: aerobic conditioning (walking and nonwalking aerobic exercise), balance, and functional strengthening[8]
  - Particpants were asked to hit 40-50% of HR reserve during the tasks
  - Outcome: greater changes in 6MWT, greater gains in peak VO2

Circuit Training and Chronic Stroke

- Task oriented circuit training specific to gait was associated with significantly higher scores in gait speed, walking distance, and modified stair tests[9]
- Despite improvements in these areas, many control groups within these studies either 1) got no treatment or 2) had treatment for UE despite functional mobility being measured
- Overall: **weak evidence** determined by CPG for Improving Locomotor Function[10]
- How do you implement circuit training in nonambulatory patients or those in the subacute phase?

Circuit Training and Subacute Stroke

- There is a critical period within the first few months post-stroke where neuroplasticity is most influenced by exercise and task practice[11,15]
- Overview of the research within the subacute population[12-14]
  - Most of the research compared additional task practice in addition to the therapy they received during their rehab stay
  - Overall improvements in walking distance, TUG, gait speed
  - One study showed a trend towards having shorter LOS in the circuit training group

A Deeper Dive[14]

Feasibility and Effectiveness of Circuit Training in Acute Stroke Rehabilitation

Dorian Rose, PhD, Trevor Paris, MD, Erin Crews, Samuel S. Wu, PhD, Anqi Sun, MS, Andrea L. Behrman, PhD, Pamela Duncan, PhD Show less

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- Compared current model of PT to a method that emphasized high repetition task-specific practice
- 1.5 hr/day, 5 day/week
- Standard PT included: gait training, transfers, bed mobility, standing and sitting balance, strengthening
- Circuit training PT: 4 tasks-specific stations, 13-14 minutes each, tailored to patients' mobility levels
- Mobility levels included: nonambulatory, severe, moderate, and mild
- Outcome Measures:
  - Gait speed
  - Berg Balance Scale
  - Lower Extremity Fugl-Meyer Motor and Sensory
  - Functional Independent Measure-Mobility

Appendix

Examples of Exercises Included in Circuit Training for Each Severity Level

Four activities were practiced within each 60-minute session, 13 to 14 minutes per activity:

Nonambulatory group
1. Rolling
2. Scooting in supine
3. Sidelying to sit
4. Static sitting balance/Equal weightbearing
5. Dynamic sitting balance
6. Scooting in sitting
7. Transfers
8. Standing
9. Sit to stand

Severe group
1. Rolling
2. Sidelying to sit
3. Dynamic sitting balance
4. Transfers
5. Sit to stand
6. Standing
7. Pregait
8. Gait

Moderate group
1. Transfers
2. Sit to stand
3. Dynamic standing balance
4. Gait
5. Stepping onto a block
6. Stairs

Mild group
1. Dynamic standing balance
2. Sit to stand
3. Gait
4. Dual task gait
5. Gait with adaptability
6. Stairs

A Deeper Dive Continued

- Results[14]
  - 97% of participants were able to fully participate in this mode of therapy
  - Circuit training PT had significantly higher intensity of task repetitions

Table 2. Repetitions per Session of Functional Tasks

Task	SPT	CTPT
Gait: steps ± SD	168.6 ± 136.2	308.6 ± 253.2
Transfers ± SD	1.4 ± 0.5	6.3 ± 10.2
Sitting balance: static ± SD	11.8 ± 15.9	2 ± 2
Sitting balance: dynamic ± SD	7.6 ± 7.9	54.7 ± 55.2[a]
Standing: static ± SD	0.61 ± 0.35	1.6 ± 0.9
Standing: dynamic ± SD	8.6 ± 14.3	86.9 ± 63.5[a]
Sit to stand ± SD	4.5 ± 3.5	14.3 ± 15.2[a]
Stairs: steps ± SD	1.5 ± 5.8	19.4 ± 15.0[a]

Abbreviations: SPT, standard physical therapy; CTPT, circuit training physical therapy; SD, standard deviation.
[a]Statistically significant difference at $P < .05$.

Results Continued

Table 6. Change Scores Between Admission and Discharge

Outcome Measure	SPT	CTPT
Lower-extremity Fugl-Meyer motor score	3.35 ± 5.48	4.51 ± 4.69
Lower-extremity Fugl-Meyer sensory score	0.48 ± 2.19	1.23 ± 2.32
Berg Balance Scale	9.46 ± 9.93	12.63 ± 13.03
Gait speed (m/s)	0.13 ± 0.22	0.21 ± 0.25[a]
FIM motor score	9.88 ± 4.73	10.26 ± 5.89
Discharge to home	78%	75%

Abbreviations: SPT, standard physical therapy; CTPT, circuit training physical therapy; FIM, Functional Independence Measure.
[a]Statistically significantly different between the SPT group and the CTPT group at $P < .05$.

Conclusions

- Circuit training is feasible in this setting with this population
- Circuit training had statistically greater changes in gait velocity
- Circuit training had higher repetitions compared to standard PT practice
- “It feels good to work hard” and “This feels like real exercise”

Key Takeaways

- High intensity, high repetitions are imperative for neuroplasticity
- Circuit training can be an avenue for this
- Although circuit training has been shown to increase repetitions and show improvements in outcome measures such as gait speed, most research is categorized as weak evidence based on control group comparisons
- Circuit training is feasible within the subacute rehab setting and systematic reviews point to it being more beneficial when delivered to the subacute population
- More research is needed within the subacute population

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