Research Paper

Investigating the Effects of Dexteria App Therapy on Hand Function in Subacute Stroke Survivors

Siddharth S Mishra[1*], **Neha Sawant**[2]

1. Department of Neuroscience Physiotherapy, MGM College of Physiotherapy, MGM Hospital, Maharashtra University of Health Sciences, Nashik, India.
2. Department of Neuroscience Physiotherapy, School of MGM Physiotherapy, MGM Institute of Health Sciences University, Navi, India.

Use your device to scan and read the article online

Citation Mishra SS, Sawant N. Investigating the Effects of Dexteria App Therapy on Hand Function in Subacute Stroke Survivors. Iranian Rehabilitation Journal. 2024; 22(2):175-182. http://dx.doi.org/10.32598/irj.22.2.395.3

http://dx.doi.org/10.32598/irj.22.2.395.3

Article info:
Received: 19 Mar 2023
Accepted: 13 Jan 2024
Available Online: 01 Jun 2024

Keywords:
Stroke, Paresis, Hand, Movement, Technology, Therapeutics

ABSTRACT

Objectives: Hand function impairment causes limitations in activities of daily living among stroke survivors. Dexteria app therapy is a game-based therapy with the use of a touchscreen gadget that involves various hand movements. This study evaluates the effect of Dexteria app therapy on hand function in sub-acute stroke survivors.

Methods: This study included 26 subacute stroke survivors, randomly allocated into 2 groups as follows: Group A (n=13) received conventional hand therapy while group B (n=13) received Dexteria app therapy. Both groups received 21 sixty-min therapy sessions. Gross hand function and fine manipulative hand function were assessed using the Brunnstrom hand recovery voluntary control grades and the Jebsen hand function test, respectively.

Results: Inter-group comparison using the Wilcoxon rank sum test of the mean difference between groups A and B showed a significant difference in the Brunnstrom hand recovery voluntary control grades Z value which equaled -3.272 with P=0.001 and Jebsen hand function test Z=-3.0 and P=0.002.

Discussion: Dexteria app therapy showed significant improvement in gross motor function and fine motor hand function than conventional therapy in sub-acute stroke survivors.

*** Corresponding Author:**
Siddharth S Mishra, Associate Professor.
Address: *Department of Neuroscience Physiotherapy, MGM College of Physiotherapy, MGM Hospital, Maharashtra University of Health Sciences, Nashik, India.*
Tel: *+91 (88) 79948943*
E-mail: *siddharth24789@gmail.comphn*

Highlights

●Dexteria app therapy is easily accessible, portable, and cost-effective allowing wide usability in any neuro-rehabilitation clinical setup. Dexteria app therapy can be considered a home exercise regime or program for hand dexterity improvement among post-stroke survivors in remote areas.

Plain Language Summary

Hand function impairment causes limitations in activities of daily living among stroke survivors. By using the Dexteria app on touch-screen gadgets, the therapy is administered in the form of a game nation that involves hand movements. This study included 26 subacute stroke survivors, randomly allocated to two groups in which 13 subjects received conventional hand therapy and the other 13 subjects received Dexteria app therapy for 21 sixty-min sessions. Gross hand function was assessed using the Brunnstrom hand recovery voluntary control grades and fine manipulation hand function was assessed using the Jebsen hand function test. Dexteria app therapy showed significant improvement in both gross motor and fine motor hand function than conventional therapy in sub-acute stroke survivors.

Introduction

Stroke is defined as rapidly developed clinical signs of focal or global disturbance of cerebral function lasting more than 24 h or leading to death with no apparent cause other than vascular origin [1-4]. It is a major cause of death and disability worldwide [2]. The estimated prevalence rate of stroke is 84-262 and 334-424 per 100000 in rural and urban areas respectively. In India, the incidence rate is 119-145 per 100000 based on a population-based study conducted in 2013 [3]. Above 80% of stroke, individuals experience hemi paresis that results in post-stroke impairments, such as unilateral upper limb and lower limb functional impairment, balance and gait impairment, cognitive dysfunction, speech impairments, and many more [5, 6]. Post-stroke deficits are prevalent in the hand [7] and account for 90% of upper limb function [8]. Common upper-limb impairments after stroke include weakness, pain, sensory loss, impaired dexterity, and in coordination [9, 10]. Hand function makes a significant contribution to most activities of daily living and its impairments can compromise function leading to difficulty in the execution of functional movements.

Hand function majorly involves prehension, precision, and manipulation movement. These movements are commonly used in most activities of daily living [11, 12]. In post-stroke survivors with impaired hand function, attaining hand function is one of the major rehabilitative goals to attain functional independence. Various therapies, such as virtual reality [12], mirror therapy [13], robotic hand therapy [14], and so on have shown a wide range and scope to attain hand function among stroke survivors. Touch screen tablet technology in healthcare is uprising [14]. Dexteria app therapy is one of them, which can be used for hand function training.

Studies have shown that Dexteria app therapy caused significant improvement in children with impaired fine and gross motor hands skills, visual motor dysfunction, poor eye-hand coordination, and handwriting difficulties [15-17, 19-21]. Studies have shown a positive correlation between Dexteria app therapy and the affected hand of stroke survivors. Studies also maintain that Dexteria app therapy has a potential effect to produce hand function improvement in post-stroke patients [18, 19]; however, literature is scarce about the effect of Dexteria app therapy on gross and fine motor hand function in stroke survivors. Accordingly, this study investigates the effectiveness of Dexteria app therapy on hand function in subacute stroke survivors.

Materials and Methods

The estimated sample size of the study was 30. Preliminary screening was carried out for 87 participants in and around Mumbai City District in India, where 26 participants met the study criteria. The study procedure was explained and written informed consent was taken from the participants. The participants in both genders were 40 to 59 years of age, all types and first-time stroke duration of less than a year, Brunnstrom hand function stage II and above, mini-mental scale examination score of 24, and Fugl-Meyer assessment upper extremity (hand component) grasp minimum score of 7 out of 14. Meanwhile, the exclusion criteria were any acute musculoskeletal condition, neurological condition (other than stroke) that would affect the intervention, and unwillingness to

Table 1. Demographic information of participants in conventional and Dexteria app therapy group

Variables		Mean±SD	
		Group A	Group B
Age (y)		50.23±8.1	52.76±8.84
Gender	Male	11	9
	Female	2	4
	Total	13	13
Dominance	Right	10	11
	Left	3	2
Side affected	Right	3	6
	Left	10	7
Post-stroke duration (m)		5.15±1.28	6.38±2.06
MMSE		25.38±5.89	27.23±1.42

MMSE: Mini-mental state examination.

Iranian Rehabilitation Journal

Notes: Group A: Conventional therapy, Group B: Dexteria app therapy.

participate in the study. The participants were randomly allocated using the lottery method into two groups (n=13 in each group). Group A received the conventional therapy while group B received the Dexteria app therapy.

Group A

Group A received the conventional therapy that included, sustained stretching of intrinsic, and extrinsic muscles of the hand and wrist, and freehand exercise within the available range of motion, including weight bearing on the table, wall, plinths, and modified push-up and quadruped position, along with functional hand precision activity training with beads, plastic bars, simulating activity like eating, typing, and grips and finger movements and manipulation activities, spherical balls, pegs blocks and shapes formation, handkerchief folding, and so on.

Group B

Group B received Dexteria app therapy version 1.3.7 android and IOS based application in a Samsung Galaxy Tab S8 Ultra 5G device with a screen size of 14.6 inches, that included 3 major components: Tap, pinch, and scribble. Various tasks, such as tapping and matching objects, pinching color-coded objects, and overwriting letters and objects were included in the treatment. All tasks had to be finished in a defined time frame (Figures 1, 2 and 3).

Both groups received 21 sixty-min sessions of therapy over 30 days. All participants' gross hand function was assessed using the brunnstrom hand recovery voluntary control grades and fine-manipulative hand function was assessed using the Jebsen hand function test on day 1 before starting and after the 21st session study protocol.

Statistical analysis

Data analysis was done using the SPSS software, version 24. All the analyzed data sets failed the normality test; therefore, a non-parametric test (Wilcoxon rank sum test) was used to compare the Jebsen hand function test and Brunnstrom hand recovery voluntary control grades between both the group and the level of significance used was $P<0.05$.

Results

Table 1 demonstrates the demographic information of the participants. The Mean±SD of group A was 50.23±8.1 years and the Dexteria app therapy group was 52.76±8.84 years. The Mean±SD post-stroke duration of the conventional and Dexteria app therapy groups were 5.15±1.28 and 6.38±2.06 months, respectively. There were 11 males and 2 females with 3 right-sided and 10 left-sided affected in conventional group A whereas the Dexteria app therapy group had 9 males and 4 female participants with 6 right-sided and 7 left-sided affected subjects.

Table 2. Intra-group pre and post-analysis of conventional therapy group using the Wilcoxon rank sum test

Outcome Measures	Median (IQR)		Z	P
	Day 1	Post 21st Session		
Jebsen hand function test	118.33 (48)	113.66 (48)	2.133	0.03*
Writing	121 (53)	112 (74)	-3.194	0.00*
Card turning	89.33 (40)	87.66 (37)	-1.888	0.05*
Small object picking	72.66 (42)	70.66 (41)	-2.341	0.01*
Simulated feeding	89.33 (56)	86.66 (47)	-2.555	0.01*
Stacking checkers	96 (57)	97 (58)	-1.868	0.06
Light object picking	87 (54)	83 (50)	-2.554	0.01*
Heavy object picking	102 (60)	95.66 (57)	-2.447	0.01*
Brunnstrom hand recovery	4 (0)	5 (0)	-3.207	0.00*

*Significant at P<0.05.

Iranian Rehabilitation Journal

IQR: Interquartile range.

Meanwhile, according to Table 2, intra-group pre- and post-analysis of conventional therapy using the Wilcoxon rank sum test showed statistically significant differences in the Jebson hand function test along with its components with Z=2.133 and P=0.03 and Brunnstrom hand recovery grades with Z=-3.207 and P=0.00.

According to Table 3, intra-group pre- and post-analysis of Dexteria app therapy using the Wilcoxon rank sum test showed statistically significant differences in the Jebson hand function test along with its components with Z=2.271 and P=0.02 and Brunnstrom hand recovery grades with Z=-3.276 and P=0.00.

Table 3. Intra-group pre and post-analysis of dexteria app therapy using the Wilcoxon rank sum test

Outcome Measures	Median (IQR)		Z	P
	Day 1	Post 21st Session		
Jebsen hand function test	918.98 (703.82)	878.32 (1024.5)	2.271	0.02*
Writing	112 (109)	89 (165)	-2.272	0.02*
Card turning	134.66 (96)	117 (94)	-3.18	0.00*
Small object picking	115.66 (116)	97 (123)	-3.181	0.00*
Simulated feeding	135.66 (143)	116.3 (149)	-3.18	0.00*
Stacking checkers	126.66 (111)	105 (106)	-3.181	0.00*
Light object picking	112.33 (50)	102.66 (61)	-3.11	0.00*
Heavy object picking	135 (113)	110.6 (128)	-2.797	0.00*
Brunnstrom hand recovery	4 (1)	5 (1)	-3.276	0.00*

*Significant at P<0.05.

Iranian Rehabilitation Journal

IQR: Interquartile range.

Table 4. Intergroup analysis of mean difference of conventional therapy and Dexteria app therapy using the Wilcoxon rank sum test

Outcome Measures	Mean Rank (A)	Mean Rank (B)	Z	P
Diff. Jebsen hand function test	9	18	-3.0	0.00*
Diff. writing	9.69	17.31	-3.545	0.01*
Diff. card turning	7.58	19.42	-3.95	0.00*
Diff. small object picking	7.15	19.85	-4.231	0.00*
Diff. simulated feeding	7.62	19.38	-3.92	0.00*
Diff. stacking checkers	7.77	101	-3.82	0.00*
Diff. light object picking	9.18	17.18	-2.873	0.00*
Diff. heavy object picking	11.15	15.85	-1.565	0.125
Diff. Brunnstrom hand recovery stage	14.38	12.62	-0.801	0.579

*Significant at P<0.05.

Iranian Rehabilitation Journal

Diff: Difference.

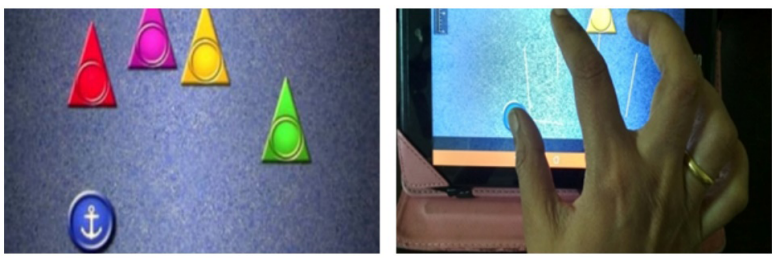

Figure 1. Tapping by placing thumb over anchor and fingers tracking objects

Iranian Rehabilitation Journal

Figure 2. Pinching of objects

Iranian Rehabilitation Journal

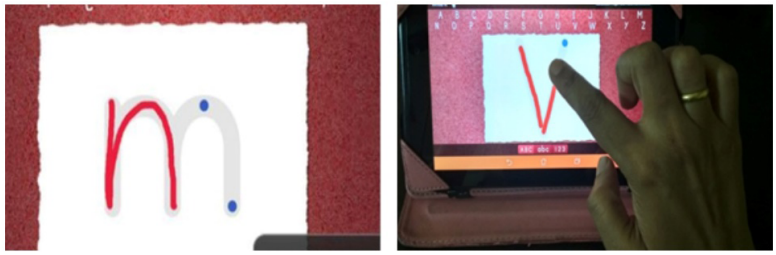

Figure 3. Scribble and tracing of alphabets or shapes

Iranian Rehabilitation Journal

According to Table 4, Inter-group comparison between groups A and B using the Wilcoxon rank sum test showed statistical significance in the mean difference of the Jebson hand function test along with its components with Z=-3.0 and P=0.00; however, there was no significance difference in mean difference of Brunnstrom hand recovery grades with Z=-0.801 and P=0.57 between both therapies.

Discussion

This study evaluated the effects of Dexteria app therapy on hand function in subacute stroke survivors. Our results stated that conventional therapy improved hand function among subacute stroke survivors (group A). The therapy included sustained stretching that helped to reduce tone in hypertonic spastic muscle, stretching creates a mechanical tension over the soft tissue structure that decreases stretch-induced muscle tone and modulates the muscle's viscoelastic excitability. Weight-bearing, range of motion exercises, and functional exercises provide constant sensorimotor integration to the brain, thereby helping to strengthen antagonist and anti-spastic muscles and allowing for high-order processing and execution of learned tasks in a functional environment. This finding is in line with a study by Hatem et al. [20] that showed significant improvement in hand function through these conventional exercises in post-stroke patients.

There was a significant improvement in hand function in subacute stroke survivors in Dexteria app therapy (group B). This could be because the Dexteria app provides a multi-touch interface for hand rehabilitation, involving multiple sensory inputs that allow and promote mimicking of virtually functional hand activities. It also allows self-learning among participants through games. The repetitive and intense training through virtual functional tasks provides an immersive nature with a high level of participant concentration. This therapy may lead to cortical reorganization and recruitment of primary motor cortex areas (M1), providing practical utility and function. The newly constructed neural pathway (neuroplasticity) must have been enhanced due to increased hand functional task, increased corticospinal drive to hand movements, and functional muscles caused remarkable improvement in hand function.

In comparison, Dexteria app therapy showed significant improvement in sub-acute stroke survivors over participants who received conventional therapy. This could be because Dexteria app therapy is task-oriented training through a touch screen medium that allows participants multiple error and correction opportunities that help them transfer these virtually trained tasks into activities of daily living. It also provided multi-sensory feedback to users through sustained visual, auditory, and tactile feedback. Received feedback was processed in the parietal lobe, in peri-personal space that must have enhanced motor learning and motor recovery [19]. Therapy also builds up a self-competition atmosphere with intensive increased concentration that leads to greater motivation and better task performance [19, 21]. It also provided motor execution of learned task transfer to the real environment with high-order cortical processing may lead to neuroplasticity thereby improving sensorimotor association of hand function and task performance. The competitive nature and multisensory model were missing in conventional therapy exercises.

Conclusion

Dexteria app therapy showed significant improvement in hand precision and hand manipulation component of hand function among subacute stroke survivors due to the multisensory model approach, intensive training nature, and also adds a recreational component in hand rehabilitation than conventional therapy. Also, both therapies are effective in bringing out improvement in voluntary control of hand movement and function.

Clinical implications

Dexteria app therapy is easily accessible, portable, and cost-effective allowing wide usability in any neuro-rehabilitation clinical setup. Home exercise regime or program for hand dexterity improvement among post-stroke survivors.

Ethical Considerations

Compliance with ethical guidelines

This research approved by the Ethical Committee of MGM Institute of Health Sciences, Navi Mumbai (Code: NEC/2019/SC/04/72) .

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors' contributions

Conceptualization, supervision, investigation, data collection and writing: Siddharth S Mishra; Methodology: All authors.

Conflict of interest

The authors declared no conflict of interest.

Acknowledgments

The authors express their sincere gratitude to organization , head of institute and patients for all the support and corporation.

References

[1] Sacco RL, Kasner SE, Broderick JP, Caplan LR, Connors JJ, Culebras A, et al. An updated definition of stroke for the 21st century: A statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2013; 44(7):2064-89. [DOI:10.1161/STR.0b013e318296aeca] [PMID]

[2] Truelsen T, Bonita R, Jamrozik K. Surveillance of stroke: A global perspective. International Journal of Epidemiology. 2001; 30(Suppl 1):S11-6. [DOI:10.1093/ije/30.suppl_1.S11] [PMID]

[3] Pandian JD, Sudhan P. Stroke epidemiology and stroke care services in India. Journal of Stroke. 2013; 15(3):128-34. [DOI:10.5853/jos.2013.15.3.128] [PMID] [PMCID]

[4] Hatano S. Experience from a multicentre stroke register: A preliminary report. Bulletin of the World Health Organization. 1976; 54(5):541-53. [PMID] [PMCID]

[5] Lawrence ES, Coshall C, Dundas R, Stewart J, Rudd AG, Howard R, et al. Estimates of the prevalence of acute stroke impairments and disability in a multiethnic population. Stroke. 2001; 32(6):1279-84. [DOI:10.1161/01.STR.32.6.1279] [PMID]

[6] Sommerfeld DK, Eek EU, Svensson AK, Holmqvist LW, von Arbin MH. Spasticity after stroke: Its occurrence and association with motor impairments and activity limitations. Stroke. 2004; 35(1):134-9.[DOI:10.1161/01.STR.0000105386.05173.5E] [PMID]

[7] Wolf SL, Winstein CJ, Miller JP, Taub E, Uswatte G, Morris D, et al. Effect of constraint-induced movement therapy on upper extremity function 3 to 9 months after stroke: The EXCITE randomized clinical trial. JAMA. 2006; 296(17):2095-104. [DOI:10.1001/jama.296.17.2095] [PMID]

[8] Harris JE, Eng JJ. Paretic upper-limb strength best explains arm activity in people with stroke. Physical Therapy. 2007; 87(1):88-97. [DOI:10.2522/ptj.20060065] [PMID]

[9] Gündüz OH, Bayindir Ö. Hand function in stroke. In: Tuncay Duruöz M, editor. Hand function: A practical guide to assessment. Berlin: Springer; 2014.[DOI:10.1007/978-1-4614-9449-2_8]

[10] Hume MC, Gellman H, McKellop H, Brumfield RH Jr. Functional range of motion of the joints of the hand. The Journal of hand surgery. 1990; 15(2):240-3. [DOI:10.1016/0363-5023(90)90102-W] [PMID]

[11] Cauraugh J, Light K, Kim S, Thigpen M, Behrman A. Chronic motor dysfunction after stroke: Recovering wrist and finger extension by electromyography-triggered neuromuscular stimulation. Stroke. 2000; 31(6):1360-4. [DOI:10.1161/01.STR.31.6.1360] [PMID]

[12] Rand D, Zeilig G, Kizony R. Rehab-let: Touchscreen tablet for self-training impaired dexterity post stroke: Study protocol for a pilot randomized controlled trial. Trials. 2015; 16:277. [DOI:10.1186/s13063-015-0796-9] [PMID] [PMCID]

[13] Yavuzer G, Selles R, Sezer N, Sütbeyaz S, Bussmann JB, Köseoğlu F, et al. Mirror therapy improves hand function in subacute stroke: A randomized controlled trial. Archives of Physical Medicine and Rehabilitation. 2008; 89(3):393-8. [DOI:10.1016/j.apmr.2007.08.162] [PMID]

[14] Kwakkel G, Kollen BJ, Krebs HI. Effects of robot-assisted therapy on upper limb recovery after stroke: A systematic review. Neurorehabilitation and Neural Repair. 2008; 22(2):111-21.[DOI:10.1177/1545968307305457] [PMID] [PMCID]

[15] Bonnechère B, Jansen B, Omelina L, Van Sint Jan S. The use of commercial video games in rehabilitation: A systematic review. International Journal of Rehabilitation Research. 2016; 39(4):277-90. [DOI:10.1097/MRR.0000000000000190] [PMID]

[16] Coutinho F, Bosisio ME, Brown E, Rishikof S, Skaf E, Zhang X, et al. Effectiveness of iPad apps on visual-motor skills among children with special needs between 4y0m-7y11m. Disability and Rehabilitation. 2017; 12(4):402-10. [DOI:10.1080/17483107.2016.1185648] [PMID]

[17] Piller A, Torrez T. Defining occupational therapy interventions for children with fine motor and handwriting difficulties. Journal of Occupational Therapy, Schools, & Early Intervention. 2019; 12(2):210-24. [DOI:10.1080/19411243.2019.1592053]

[18] Rand D, Schejter-Margalit T, Dudkiewicz I, Kizony R, Zeilig G. The use of the iPad for post-stroke hand rehabilitation; a pilot study. Paper presented at: 2013 International Conference on Virtual Rehabilitation (ICVR). 26 August 2013; Philadelphia, USA. [Link]

[19] Short N, Harmsen R, Kjellgren G, O'Neill C, Pinney H, Rivera AD, et al. Use of dexteria application to improve fine motor coordination in the nondominant hand. Journal of Hand Therapy. 2017; 30(1):106-8. [DOI:10.1016/j.jht.2016.03.014] [PMID]

[20] Hatem SM, Saussez G, Della Faille M, Prist V, Zhang X, Dispa D, et al. Rehabilitation of motor function after stroke: A multiple systematic review focused on techniques to stimulate upper extremity recovery. Frontiers in Human Neuroscience. 2016; 10:442. [DOI:10.3389/fnhum.2016.00442] [PMID] [PMCID]

[21] John S, Renumol VG. Design and development of an android app (HanDex) to enhance hand dexterity in children with poor handwriting. IEEE Access. 2022; 10:48973-93. [DOI:10.1109/ACCESS.2022.3172330]

This Page Intentionally Left Blank