Comparison between Erigo robotic tilt table exercises and Traditional exercises in rehabilitation of stroke patients: A follow up study

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***Abstract*— Background: Stroke is a major cause of disability and mortality often associated with secondary complications which can postpone or prevent recovery. Early intervention by mobilization averts such negative effects and promotes the recovery.**

Purpose: To compare between Erigo robotic tilt table exercises and Traditional exercises in rehabilitation of stroke patients.

Methods: A total of 100 stroke patients (age 50.99 ±7.68 years) were assigned randomly into two groups, 50 in each for 30 days of Traditional physiotherapy (Group A) or Erigo robotic tilt-table (Group B) rehabilitation. The National Institutes of Health Stroke Scale (NIHSS), Mini Mental Scale Examination (MMSE), Modified Ashworth Scale, Quality of Life (QOL) and muscle strength (affected upper and lower limb) outcomes were assessed at baseline (day 0), after (day 30) of the intervention, on 90th day and 180th day of follow up.

Results: Both the treatments were effective. Notably, Erigo robotic tilt table group had a significant improvement in Quality of life (p=0.0001), NIHSS (p=0.0025), upper limb strength (p=0.0179) and lower limb strength (p=0.0002) as compared to traditional exercises group.

Conclusion: Both the interventions were found to be effective but Erigo robotic tilt-table group showed faster and better improvement thus, it can be used in clinical practice in order to prevent the secondary complications and improve the functional outcomes in stroke survivors.

Keywords— physiotherapy, Erigo robotic tilt table, muscle strength, home-exercise program, robotics

I. INTRODUCTION

Stroke has been well established as a leading cause of disability and mortality worldwide [1]. Despite advancements in the acute management of stroke patients, a large proportion of stroke patients remained with significant impairments. The aims of rehabilitation for stroke patients are to restore normal function and improve quality of life [2].An effective and structured rehabilitation is the key reason for reducing disability in stroke patients with neurological and functional deficits. Although the rate and speed of recovery varies among stroke patients, studies have suggested that functional recovery is predictable in the early days after stroke [3,4]and the long-term survival is predicted by the functional outcome at 6 months[5].

Early mobilization after stroke onset is thought to be an important component of stroke rehabilitation, which potentially contributes to improved outcomes after acute stroke [6]. Early weight bearing by standing may result in the reduction of muscle tone and an increase in range of motion or muscle length [7,8,9]. There is a reported increase in a sense of well-being and quality of life related to standing and a general sense of improved fitness [10, 11].

The automatic lower limb motion during locomotion are provided by electromechanical/ robotic devices, that were developed to help the physiotherapists by increasing the safety, intensity and standardization of non-robotic body weight supported treadmill training, generate complex multisensory stimulation, offer extensively extrinsic biofeedback to the patient, and reduce working costs[12].

Robotic verticalization maximizes the potential for longitudinal weight-bearing through the lower extremities in hip-extension/knee-extension/ankle-dorsiflexion, which is strenuous in achieving by traditional physiotherapy. Moreover, Robotic verticalization gives opportunity for strengthening exercises by body weight shifting from one leg to the other, which is usually not carried out in severe post-stroke patients [13].

Thus this study hypothesized that Robotic tilt table exercises followed by a home-exercise program will be more effective than traditional exercises followed by a home exercise program in the rehabilitation of stroke patients.

METHODOLOGY:

Experimental Approach to the Problem: This is a single blinded (Subjects) randomized control trail.The National Institutes of Health Stroke Scale (NIHSS), Mini-Mental Scale Examination (MMSE), Modified Ashworth Scale, Quality of Life (QOL) and muscle strength (affected upper and lower limb) were assessed by same tester and same physiotherapist supervising the test procedure pre-treatment and post treatment.

Subjects: Total 365 hemiplegia patients from in-patient and out-patient department of Neurology, of the research institute where this study is been carried out, aged 30–60 years either male or female diagnosed clinically by a neurologist with ischemic or hemorrhagic stroke, within 7-28 days of onset and National Institutes of Health Stroke Scale (NIHSS) between 11-22 were included for this study. Out of 365, 133 patients were found suitable and randomized to treat either with traditional physiotherapy (n=70) or Erigo robotic tilt table (n=63) treatments (Fig. 1). Among 70 patients of traditional physiotherapy group 15 subjects were excluded due to recurrent stroke (n=4), lost to follow up (n=7) and death (n=4). Whereas from 63 patients of Erigo robotic tilt table group 8 patients were excluded due to death (n=4) and lost to follow up (n=4). Thus, both the groups were left with 55 patients in each who had completed their follow up at 90th day. Further, out of this 55 patients in traditional physiotherapy group 5 subjects were excluded due to death (n=3) and lost to follow up (n=2). Also from 55 patients of Erigo robotic tilt table group 5 patients were exclude due to recurrent stroke (n=1) and lost to follow up (n=4). Then both the groups were left with 50 patients in each who had completed their follow up at 180th day. The present study has the approval of the Institutional Local Ethical Committee and informed consent was obtained from all the participants. Subjects were excluded from the study if they are with metal implants, recurrent stroke, chronic renal failure, cognitive and speech problems, hemiplegia due to non-vascular causes (malignancy, infections, tumours, brain injury, etc.), sensation loss in the lower extremity and poor sitting balance.

Approach

The subjects were randomized into two groups by lottery method [14], Group A for traditional physiotherapy and Group B for Erigo robotic tilt-table rehabilitation. Marking on the paper drawn by the patient allocates their mode of treatment. The demographic characteristics such as age, weight, height, BMI (body mass index), the side affected, the onset of stroke (duration) of two treatment groups were assessed at baseline before randomization. Similarly, outcome variables such as National Institutes of Health Stroke Scale (NIHSS), Mini-Mental Scale Examination (MMSE), Modified Ashworth Scale, Quality of Life (QOL) and muscle strength (affected upper and lower limb) were also assessed by same tester and same physiotherapist supervising the test procedure at baseline (day 0) as well end of the treatment (day 30) and on follow up (day 90 and 180). Test and retest of two groups were conducted in the same place in the same environment. Before experimentation, all subjects were well taught about the measurement variables and their outcomes. The subjects were also informed about the experimental risks if any.

Procedure

After group allocations, respective subjects treated either with traditional physiotherapy or Erigo robotic tilt table therapy. Both treatments were given by the same physiotherapist for 30 regular days (except Sunday) and reassessment took after 30 days, on follow-up at 90th day and 180th day. The duration of each individualized treatment session was about 50 to 60 minutes per day. All subjects allowed taking treatment for their comorbid conditions like hypertension, dyslipidemia, hypothyroidism, the cardiac problem in both the conditions under the supervision of Neurologists. No other treatment allowed other than mention above.

Follow up

In the period of 30-90 days and 90-180 days subjects were asked to do a home-exercise program. All the patients were provided with the home-exercise booklet which includes written instructions and figures. These exercises were ones asked to do under the supervision of the physiotherapist then to continue at home on their own or with the help of attendants. During this period the patients were contacted at the interval of every 15 days either at the hospital or telephonically to know whether they are performing the exercises properly or not. Patients can come for follow up at any time during this period when they forget or have any other problem while performing it.

Training protocols

Traditional physiotherapy (Group A)[15]

- The exercises are done for a 2 sets of 10 repetitions, with 10 seconds hold once in a day under the supervision of physiotherapist which includes the following:

- Full range of motion (ROM) exercises – passive and active-assisted range of motion exercises for upper limb included shoulder (flexion, extension, abduction and adduction), elbow (flexion and extension), forearm (supination and pronation), wrist (flexion, extension, radial, and ulnar deviation), and for lower limb included hip (flexion, extension, abduction, and adduction), knee (flexion and extension), ankle (dorsiflexion, plantar flexion, eversion, and inversion).

- For spasticity management - Positioning of the limb, prolong icing, brushing, gentle stroking, and gentle tapping [16, 17, 18]. The common mat activities include turning from supine to side-lying to prone and vice versa, prone to prone on elbow, prone on elbow to prone on hand; prone on hand to quadripud; quadripud to kneeling; kneeling to half kneeling; half kneeling to standing with support; standing with support to the standing without support.

- Bridging exercises.

- Prolonged and gradually progressive stretching of hamstring, calf and wrist.

- Strengthening exercises included isometrics of back, quadriceps, griping exercises.
- The gentle and controlled weight bearing exercises.
- Balance and coordination exercises.

Erigo robotic tilt-table therapy (Group B)

Erigo tilt-table therapy was administered according to the following protocol. Patient received treatment session of 40 minutes, 6 times per week [11] for about 4 weeks [19]

After the Robotic tilt table exercise session, a 15 minutes exercise program for upper extremities which includes a range of motion, strengthening and stretching exercises of the shoulder, elbow, wrist, and fingers were done. Any specific gait training was not administrated to both the groups but ambulation suggested to all the patients when they were able to ambulate.

Figure 1: Erigo tilt table therapy protocol.

Outcome variables

The assessment of QOL was done according to SF-36 assessment tool [20]. It is a multipurpose, self-administered, short form (SF) health survey with 36 questions which measures generic health status in the general population. These questions consist of physical functioning, role functioning (physical and emotional), body pain, general health, vitality, social functioning and mental health. Response choices are numbered from left to right, starting with 1. The highest scores obtained from 36 questions where 149 which representsbest QOL where minimum score 36 represents the worst [21]. The scale was used earlier in acute stroke patients [22,23].

Muscle strength assessed by MRC (Medical Research Council) classification of Manual Muscle Testing (MMT). The Overall upper limb and lower limb muscle strength was recorded. For upper limb MMT was performed for shoulder flexion, shoulder extension, shoulder abduction, shoulder adduction, shoulder external rotation, shoulder internal rotation, elbow flexion, elbow extension, forearm pronation, forearm supination, wrist palmar flexion, wrist dorsal flexion, ulnar deviation and radial deviation. Then the average score of these was considered as overall upper limb muscle strength. Similarly for lower limb MMT for hip flexion, hip extension, hip abduction, hip adduction, hip external rotation, hip internal rotation, knee flexion, knee flexion with leg external rotation, knee flexion with leg internal rotation, knee extension, ankle plantar flexion, ankle plantar flexion (soleus), foot dorsiflexion and inversion, foot inversion, foot eversion with plantar flexion and foot eversion with dorsiflexion. The average score of these was recorded as overall lower limb muscle strength. The positioning of the patients for performing MMT was according to standard norms and was also used earlier in a published study [24,25]

The National Institutes of Health Stroke Scale, or NIH Stroke Scale (NIHSS) is a tool used by healthcare providers to objectively quantify the impairment caused by a stroke. The NIHSS composed of 11 items, each of which scores a specific ability between a 0 and 4. For each item, a score of 0 typically indicates the normal function in that specific ability, while a higher score is indicative of some level of impairment. The individual scores from each item are summed in order to calculate a patient's total NIHSS score. The maximum possible score is 42, with the minimum score being a 0 [26].

The Mini–Mental State Examination (MMSE) is a 30-point questionnaire used extensively in clinical and research settings to measure the cognitive impairment. Administration of the test takes between 5 and 10 minutes and examines functions including registration (repeating named prompts), attention and calculation, recall, language, ability to follow simple commands and orientation. Any score greater than or equal to 24 points (out of 30) indicates a normal cognition. Below this, scores can indicate severe (≤9 points), moderate (10–18 points) or mild (19–23 points) cognitive impairment [27].

The Modified Ashworth Scale is a 6-point rating scale that is used to measure muscle tone with ratings from 0 indicating no increase in tone to 5 indicating limb rigid in flexion or extension [28]. For upper limb the scores of shoulder adductor, elbow flexor and wrist flexor was recorded whereas for lower limb scores of hip adductor, knee extensor and ankle planter flexor was recorded. The average of these readings was considered as the global score [29].

STATISTICAL ANALYSIS

The un-paired t- test was used to analyse the improvement in outcome variables between the groups. Whereas for comparing the demographic variables the un-paired t test was used for interval variables (age, height, weight, BP systolic and diastolic) and chi square test was used for categorical variables (sex, type and side of lesion).MS EXCEL (MS Office 97-2013) were used for the analysis. Probability (P) value between 0.05 ($P < 0.05$) was considered statistically significant; and $P > 0.05$ had no significance (ns).Values are reported as mean ± standard deviation (SD).

RESULTS

Demographic characteristics

The baseline demographic characteristics of two groups is summarised in Table 1. On comparing, the baseline demographic characteristics were found similar (p>0.05) between the two groups i.e. two groups were demographically matched or comparable hence may not influence the study outcome measures.

Table 1: Demographic characteristics (Mean ± SD) of two groups

Demographic characteristics	Group A (n=50) (%)	Group B (n=50) (%)	p value
Age (yrs)*	51.16 ± 8.27	50.82 ± 7.09	0.826
Sex:			
Male	28 (56.0)	28 (56.0)	1.000
Female	22 (44.0)	22 (44.0)	
Weight (kg)*	65.40 ± 9.91	64.10 ± 7.17	0.454
Height (m)*	1.60 ± 0.09	1.61 ± 0.09	0.904
BMI (kg/m2)*	25.45 ± 3.82	24.87 ± 2.58	0.380
SBP (mmHg)*	134.40 ± 15.93	133.20 ± 14.77	0.697
DBP (mmHg)*	86.00 ± 9.04	84.20 ± 8.83	0.316
Side affected:			
Right	26 (52.0)	24 (48.0)	0.689
Left	24 (48.0)	26 (52.0)	
Lesion:			
Haemorrhagic	28 (56.0)	25 (50.0)	0.548
Ischemic	22 (44.0)	25 (50.0)	

Group A: Conventional physiotherapy, **Group B:** Erigo tilt-table, **BMI:** body mass index, **SBP:** systolic blood pressure, **DBP:** diastolic blood pressure
*Mean+/-SD

OUTCOME MEASURES

The pre (day 0) and post (day 90 and day 180) outcome measures of two groups is summarised in Table 2 and also depicted in Fig. 2. Comparing the outcome measures of two groups over the periods (time), ANOVA showed significant effect of groups on QOL (F=21.32, p<0.001), MMT-LE (F=9.94, p=0.002), MMT-UE (F=6.90, p=0.010) and NIHSS (F=8.69, p=0.004) and periods on QOL (F=477.27, p<0.001), MMT-LE (F=962.65, p<0.001), MMT-UE (F=1064, p<0.001), NIHSS (F=2681.40, p<0.001), MMSE (F=818.14, p<0.001) and Ashworth (F=20.85, p<0.001). Further, the interaction effect of both groups and periods (Groups*Time) on QOL (F=15.43, p<0.001) and MMT-LE (F=3.43, p=0.034) were also found significant (Fig. 2).

Table 2: Outcome measure score (Mean ± SD, n=50) of two groups over the periods

Outcome measure	day 0	day 90	day 180
QOL:*			
Group A	75.86 ± 6.53	90.92 ± 11.54**a**	100.10 ± 12.67**ab**
Group B	78.06 ± 8.80	102.06 ± 11.23**a**	111.74 ± 11.44**ab**
p value#	1.000	<0.001	<0.001
MMT-LE:*			
Group A	1.28 ± 0.97	3.44 ± 0.85**a**	4.10 ± 0.84**ab**
Group B	1.49 ± 0.98	3.97 ± 0.47**a**	4.66 ± 0.55**ab**
p value#	1.000	0.020	0.009
MMT-UE:*			
Group A	0.87 ± 0.91	3.01 ± 0.87**a**	3.79 ± 0.91**ab**
Group B	1.24 ± 0.84	3.44 ± 0.83a	4.22 ± 0.91**ab**
p value#	0.518	0.222	0.205
NIHSS:*			
Group A	12.38 ± 1.54	3.78 ± 1.85**a**	2.40 ± 2.07**ab**
Group B	11.88 ± 1.44	2.74 ± 1.94**a**	1.22 ± 1.72**ab**
p value#	1.000	0.057	0.016
MMSE:*			
Group A	15.62 ± 4.40	24.68 ± 2.58**a**	25.92 ± 2.11a*b*
Group B	16.00 ± 4.02	24.58 ± 2.70**a**	26.18 ± 2.21ab
p value#	1.000	1.000	1.000
Ashworth:*			
Group A	0.10 ± 0.30	0.56 ± 0.58**a**	0.34 ± 0.63
Group B	0.12 ± 0.33	0.42 ± 0.57a	0.16 ± 0.47*b*
p value#	1.000	1.000	1.000

Group A: Conventional physiotherapy, **Group B:** Erigo tilt-table, **QOL:** quality of life, **MMT-LE:** manual muscle testing (lower extremity) or overall lower limb strength, **MMT-UE:** manual muscle testing (upper extremity) or overall upper limb strength, NIHSS: national institute of health stroke scale, **MMSE:** mini-mental state examination, **Ashworth:** Ashworth scale-6. **#**(inter group comparison), ap<0.01 or **a**p<0.001- as compared to day 0 and *b*p<0.05 or bp<0.01 or **b**p<0.001- as compared to day 90 (intra group comparison).
*Mean+/- SD.

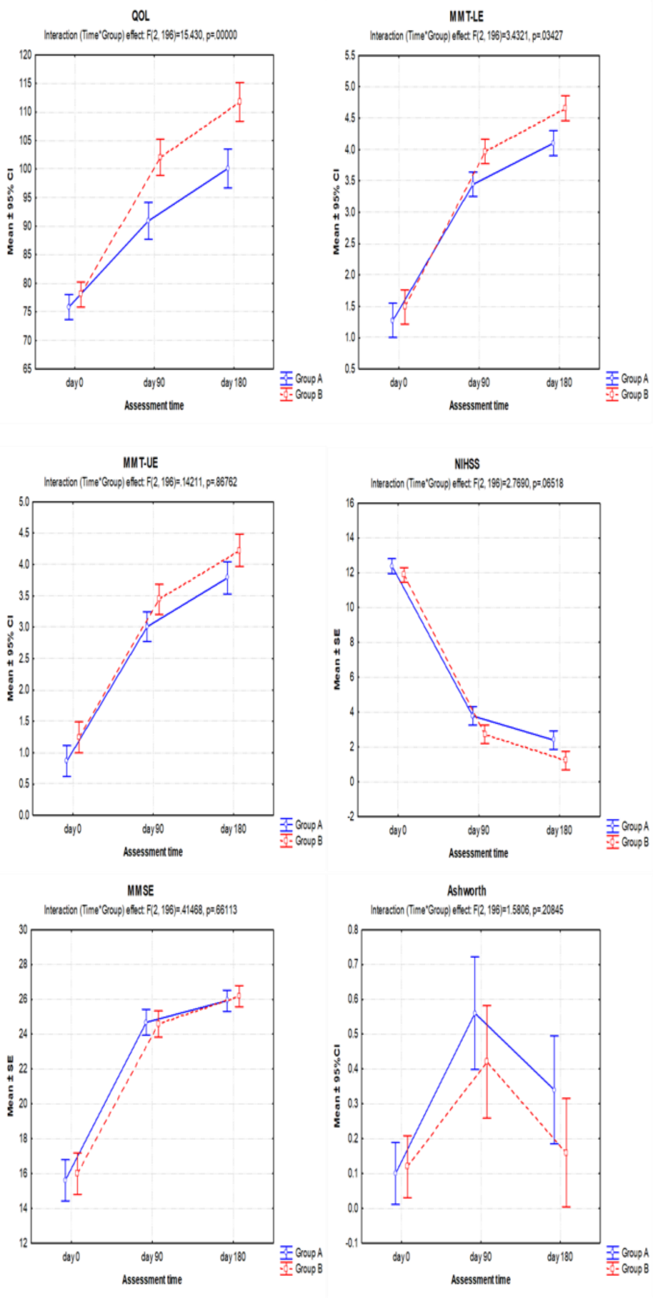

Fig. 2. Line graphs showing mean outcome measure score of two groups over the periods with interaction effect. Vertical bars denote 95% confidence interval (CI). Group A: Conventional physiotherapy, Group B: Erigo tilt-table

Further, for each outcome measure, comparing the difference in mean across the periods (intra group), Bonferroni test showed significant (p<0.01 or p<0.001) increase (improvement) in QOL, MMT-LE, MMT-UE, MMSE and Ashworth whereas significant (p<0.001) decrease (improvement) in NIHSS at both day 90 and day 180 as compared to day 0 in both groups (except Ashworth at day 180) (Table 3).

Table 3: Mean change in outcome measure score (Mean ± SD) between two groups

Outcome measure	Group A (n=50)	Group B (n=50)	p value
QOL:*			
day 0 to day 90	15.06 ± 8.92	24.00 ± 10.10	<0.001
day 0 to day 180	24.24 ± 11.49	33.68 ± 11.95	<0.001
day 90 to day 180	9.18 ± 6.59	9.68 ± 6.98	0.713
MMT-LE:*			
day 0 to day 90	2.17 ± 0.75	2.47 ± 0.82	0.056
day 0 to day 180	2.82 ± 0.82	3.17 ± 0.91	0.051
day 90 to day 180	0.66 ± 0.42	0.69 ± 0.41	0.661
MMT-UE:*			
day 0 to day 90	2.14 ± 0.78	2.20 ± 0.62	0.680
day 0 to day 180	2.92 ± 0.83	2.98 ± 0.68	0.677
day 90 to day 180	0.78 ± 0.54	0.78 ± 0.43	0.958
NIHSS:*			
day 0 to day 90	-8.60 ± 1.91	-9.14 ± 1.54	0.122
day 0 to day 180	-9.98 ± 2.15	-10.66 ± 1.29	0.058
day 90 to day 180	-1.38 ± 0.95	-1.52 ± 0.89	0.447
MMSE:*			
day 0 to day 90	9.06 ± 3.48	8.58 ± 2.79	0.449
day 0 to day 180	10.30 ± 3.65	10.18 ± 3.00	0.858
day 90 to day 180	1.24 ± 1.17	1.60 ± 1.25	0.140
Ashworth:*			
day 0 to day 90	0.46 ± 0.65	0.30 ± 0.58	0.195
day 0 to day 180	0.24 ± 0.72	0.04 ± 0.45	0.098
day 90 to day 180	-0.22 ± 0.62	-0.26 ± 0.53	0.728

Group A: Conventional physiotherapy, **Group B:**Erigo tilt-table, **QOL:** quality of life, **MMT-LE:** manual muscle testing (lower extremity) or overall lower limb strength, **MMT-UE:** manual muscle testing (upper extremity) or overall upper limb strength, **NIHSS:** national institute of health stroke scale, **MMSE:** mini-mental state examination, **Ashworth:** Ashworth scale-6.
*Mean+/-SD

Furthermore, in both groups, QOL, MMT-LE, MMT-UE, MMSE and Ashworth also show significant (p<0.05 or p<0.01 or p<0.001) increase whereas

NIHSS show significant ($p<0.001$) decrease at day 180 as compared to day 90 (except Ashworth in Group A).

Similarly, for each outcome measure, comparing the difference in mean between the groups (inter group), Bonferroni test showed similar ($p>0.05$) mean between the groups at day 0 indicating all outcome measures comparable (Table 3). However, at both day 90 and day 180, QOL and MMT-LE both showed significant ($p<0.05$ or $p<0.01$ or $p<0.001$) improvement in Group B as compared to Group A. Further, at day 180, NIHSS showed significant ($p<0.05$) improvement in Group B as compared to Group A.

Net improvement

In this study to find out efficacy of one group over other, the mean change (day 0 to day 90, day 0 to day 180 and day 90 to day 180) in outcome measures were compared by independent Student's t test and summarised in Table 3. The Student's t test showed significant improvement in mean change in QOL ($p<0.001$) from both day 0 to day 90 and day 0 to day 180 of Group B as compared to Group A. However, other outcome measures did not ($p>0.05$) show significant improvement in one group other group i.e. found to be statistically the same.

DISCUSSION

The results demonstrate that theErigo robotic tilt table exercises followed by home-exercise program will be more effective than traditional exercises followed by home exercise program in the rehabilitation of stroke patients. The variables assessed like QOL, NIHSS, Ashworth, muscle strength of upper and lower limb improved higher in Group B except MMSE. One month of Erigo robotic tilt-table training followed by home rehabilitation intervention produced better improvement in functional independence, ability, and quality of life than did usual care. Erigo robotic tilt table intervention appears to have accelerated recovery within six months compared to traditional physiotherapy. Early intervention by rehabilitation in the acute stage optimizes the patient's potential for functional recovery.

There are three main processes implicated in neurorecovery: angiogenesis, neurogenesis, and synaptic plasticity. These processes are naturally produced in adult brains later to intensive rehabilitation, which could promote an endogen neuro-repair phenomenon [30].

The improvement could be related to the fact that Erigo robotic tilt-table rehabilitation may offer standardized, intensive and repetitive exercises, a proper body weight support, with an appropriate sensory feedback amount and a controlled progressive verticalization. It was also found in a study ERIGO training could be a valuable tool for the adaptation to the vertical position with a better global function improvement, as also suggested by the sensory-motor and vestibular system plasticity induction in post-stroke patients [13]. Some studies found that greater cerebral blood flow modulation during Robotic VT in comparison to physiotherapy VT could further support plastic changes within sensory-motor areas and vestibular system, with the consequent motor and cognitive function amelioration [32,33].

In severely impaired or non-cooperating patients for improving circulation, preventing contractures and increasing pulmonary ventilation, the rehabilitation on a tilt-table is a useful way to mobilize [34,35]. Our study support the safety and effectiveness of Erigo robotic tilt table verticalization in bed -ridden post-stroke patients even in the acute phase.

Our study suggests that reduction in the motor impairments are more after tilt-table exercises as it is preventing long-term spasticity and improving strength. Our study supports the study that showed a significant great increase in the EMG patterns of the extensors and flexors of the affected leg muscles during flexion and extension movements of both legs and clinical scores in patients undergoing the progressive task-oriented training on the tilt table compared to the other groups [36].

Robotic tilt table is an effective tool in preventing the blood pressure drops, orthostatic hypotension [37], to verticalization by improving the venous return and, hence, promotes the cardiac output and the cerebral blood flow. In addition to improving orthostatic tolerance, Robotic tilt-table may also be an effective exercise tool in initiating the rehabilitation process at the earliest possible time point after stroke may lower the reduction in aerobic fitness that occurs due to inactivity. It was also found that robotic tilt-table can be used to provide a strong training stimulus to complement conventional physiotherapy practices and serve the dual purpose of increasing orthostatic tolerance and attenuating the decline in aerobic fitness [39].

Several studies proved that verticalization (VT) may play a role in stimulating cortical areas involved in the trunk and lower limb control, so that deafferentation and learned non-use can be contrasted [40]

In our study the Ashworth scores, when compared at 0-180 days, were higher in conventional physiotherapy than the robotic tilt table group. The scores of the robotic tilt table were found to increase initially but at the end remain the same which shows that tilt-table prevents spasticity. One of the findings also showed that extensor spasms were reduced after the tilt table standing [41]. Robot-based rehabilitation has been shown to improve motor performance by boosting brain plasticity [42,43].

In this study MMSE improved equally in both the groups but studies reported that verticalization may actively contribute to enhancing cognitive performances through an increase in cerebral blood flow with consequent induction of cortical plasticity, especially in frontal lobes [44].

The duration of hospital stays for the rehabilitation of acute stroke patients has decreased, so recovery often is not complete at the time of discharge. The consequences after discharge may involve not only persistent neurological impairment but also lifetime disability. Thus, a further exercise program is needed to maximize patients' function in overcoming their disabilities.

Several studies have suggested that home rehabilitation is more effective and cheaper than usual care [45,46]. It may not be possible for therapists to supervise all rehabilitation, especially in a home environment. Therefore, adherence to home exercise programs is important [38], and would allow for potential savings in treatment cost and help to avoid morbidity and unwanted side effects [47]. It also has a positive effect on functional outcomes [48]. Robotic verticalization includes increased ventilation, increased arousal, improved weight-bearing of the lower limbs, and facilitation of antigravity exercise of the limbs [49].

The robot-assisted movement practice may make the central nervous system ready for more complicated and difficult task practice by activating beforehand the cortex region that is needed for voluntary movements which are known as "motor priming" [31].

The several repetitions of rhythmic movements could act as an external proprioceptive cue, by reinforcing the neuronal circuits that contribute to limb movements. Robot assisted training offer an external rhythm that could improve motor output bypassing the deficient internal motor generation system that would support the generation on actions based on intention and internal reference frame [50].

Thus, the tilt-table intervention followed by a home-exercise program proves to be much more beneficial in rehabilitation of stroke patients as it prevents the detoriation after hospital discharge and supports in sustaining the achieved improvement and help in further improvement of patients to gain most function and reduce dependency.

CONCLUSION:

The study concludes that both the Robotic tilt-table and conventional physiotherapy are found to be beneficial and effective in rehabilitation of acute stroke patients. In both the treatments, the robotic tilt table intervention showed higher improvement for all the assessed variables (QOL, NIHSS, Ashworth, muscle strength lower and upper limb) except MMSE. This study may help to inform the integration of current evidence for robotic tilt-table into stroke rehabilitation, encourage practitioners and researchers to evaluate their current management algorithms for patients with stroke. Robotic tilt- table exercises can be practised for rehabilitation of acute stroke patients where early mobilization is difficult and delayed due to trunk instability, orthostatic hypotension, reduce vigilance and cooperationFigures and Tables

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