Effects of Pilates exercise on balance in stroke: A systematic review

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ABSTRACT

Balance impairment is commonly experienced in post stroke survivors. Functional retraining by conventional stroke rehabilitation program does not overcome the deficit on all kinds of stroke cases. Pilates exercise had shown positive effects in improving balance and functional activity in many elderly people. Aim of the study is to systematically review the effects of Pilates in stroke balance rehabilitation, which systematically reviewed in this study. Studies were collected from database such as Cochrane Library Trials, PubMed central, PEDro, Rehab data, Research Gate, and SAGE Journals. Inclusion criteria was randomized or quasi-randomized controlled clinical trial studies; subjects with minimum cognition level of 24-30 according to MMSE grade, and who was ambulatory. Studies with participants of any adult age with a clinical diagnosis of stroke were included. Intervention focused was therapeutic Pilates exercise aimed at improving balance. Outcomes measured were static and dynamic balance. Three RCT's were finally refined and analysis showed that "Pilates exercise is effective than conventional exercise as it showed some significant changes in improving balance in a short term". This study concludes that Pilates exercise has a positive effect on Static and dynamic balance in a stroke rehabilitation provided, an insufficient number of evidence was available to confirm it. Small numbers and heterogeneous outcomes limited the analyses, and comparisons. Further investigation is required with large number of data.

Keywords: Hemiplegia; cerebrovascular accident; balance.

INTRODUCTION

Stroke (cerebrovascular accident; CVA), is the sudden loss of neurological function leading to functional impairment caused by reduced blood flow to the brain (1). The estimated prevalence rate of stroke in India range from, 84-262/100,000 in rural and 334-424/ 100,000 in urban areas, in a recent population base study (2). It has been reported that 83% of people suffering from stroke have balance impairment (3). Balance is generally termed as an ability to maintain body mass over the base of support in standing, sitting, reaching and during movement. Balance impairment is an important risk factor for fall and leads to delayed development of activities of daily living (4).

Asymmetric weight bearing and postural sway causes deterioration of balance, which is most common among hemiplegic people (5). Reflex muscular activity and coordinated voluntary movement is a necessary for Balance adjustment, which is acquired through Postural adjustments (6, 7). Trunk muscle strength and stability help in acquiring postural adjustments, which are determined by interaction of body response to changes in gravity, base of support, vision, and the external environment (8).

Joseph Hubertus Pilates first introduced Pilates exercise at early 1990's. This method was introduced as–Art of Control for improving muscle control in the process of rehabilitation (9, 10). Both traditional and contemporary Pilates exercise follows principles of centering, concentration, control, precision, flow of movement, and breathing which are the major factors in facilitating movement re-education (11-13). Pilates exercise help in attaining dynamic balance in an upright position byimproving flexibility, strength, postural controlusing resistance and changing the body's orientation to gravity (14, 15). Pilates concentrates in abdominal muscle strength in all its variety of exercises in comparison to routine exercises, in a neutral spine posture, and thereby exhibits trunk control and balance in erect posture (16, 17).

Many studies have reported that Pilates exercise has positive effects in development of muscular strength, endurance, flexibility, weight reduction and in prevention of falls in elderly population, has high influence in management of healthy pregnancies, in chronic low backache, and in orthopedic rehabilitation (18). However, there are only a few studies available with Pilates as intervention in neurological conditions such as multiple sclerosis, Parkinson's disease and stroke. This systematic review is conducted with Stroke RCT studies to evaluate the efficacy of Pilates exercise on balance, in post stroke survivors and thereby provide an evidence for further studies in neurological conditions.

MATERIALS AND METHODS

Study design

This Systematic Review was conducted based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analysis) guidelines.

Eligibility criteria

Selection of studies

The databases used for searching articles were Cochrane Library Trials, PubMed Central, PEDro, Rehab data, Research Gate, and SAGE Journals. Results yielded from PubMed Central were 119, (Table 1), PEDro Database 2, RehabData 2, Cochrane Library Trials 1, Research Gate 8 and SAGE Journals 2. Totally 134 articles, ended up with keywords– Stroke, Pilates, Hemiplegia, cerebrovascular accident and balance. All articles are scrolled between the years 1999 to 2019.

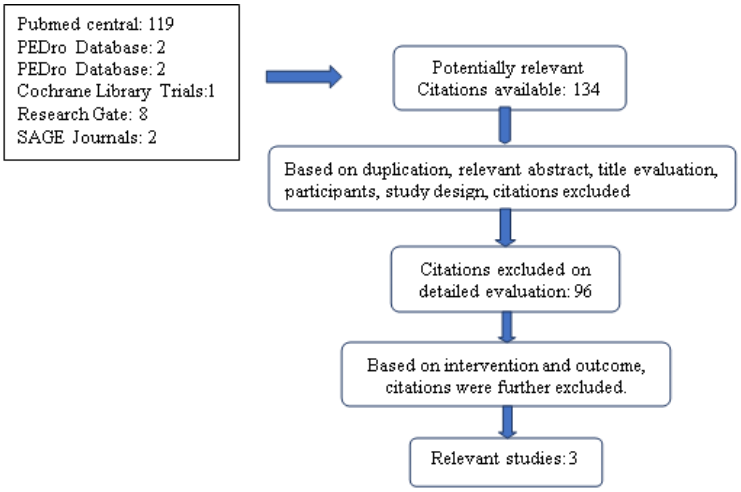
Inclusion and exclusion criteria

Studies such as Clinical trials, randomized-controlled trials have been included, excluding reviews, case reports and Meta-analysis articles. Only population of stroke survivors has been included, which is of both ischemic/hemorrhage type of onset. Any location of lesion was included, provided there should not be cognitive and visuospatial deficit. Survivors at acute, sub-acute and chronic stages of stroke were included. Study was selected based on type of study design, title and abstract with relevance to review, participants of stroke survivors, inclusion, and exclusion criteria was focused and finally the refined article was completely assessed for reviewing. Article that does not full fill the criteria with this review were excluded. Reports, which are free to assess, was examined.

Types of intervention

Studies that involved Pilate's therapeutic exercise were included. Any other exercises combined with Pilates were also included, excluding studies when the modalities are combined.

Table 1: Study selection strategy

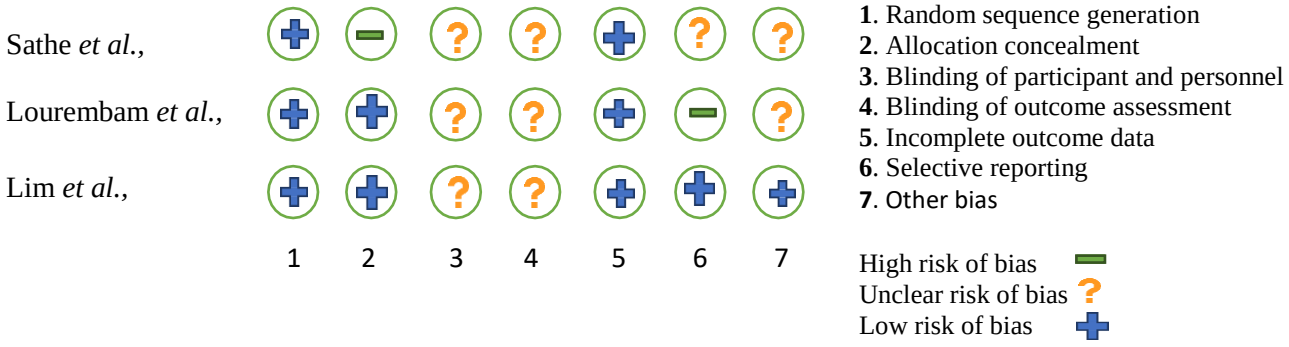


Statistical method

Assessment of study characteristics and risk of bias: Papers were critically analyzed for their methodological quality. Risk of bias was assessed using Cochrane Risk of Bias Tool (19, 20). It evaluated seven sources of bias, including randomization, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, completeness of outcome data, selective outcome reporting, and other potential bias and evaluated as being low risk, high risk, or unclear risk.

Data extraction and analysis: Data were extracted as based on characteristics (21) and observed effects in Table 3. Descriptive analysis was used to compare the study characteristics: study design, type of stroke, demographic data, number of participants, type of intervention, duration, frequency and outcome measured (22).

Table 2: Cochrane Risk of Bias Tool



RESULTS

Study flow: A total number of 51 stroke survivors were observed. Experimental group (n=10) received mat based Pilates exercise alone and (n=17) received conventional balance exercise with Pilates exercises. Control group (n=9) received no exercise and (n=15) received conventional balance exercise. All these were thoroughly investigated. Most of the study included participants from chronic stage, and one study included participants in sub-acute stage. Final list of studies was selected after exclusion. Exclusion factors were duplication, population should be of stroke survivors, should have focus on balance outcome criteria and Pilates or Pilates based exercise should be the major contributing intervention.

Quality of studies and risk of bias

In Cochrane Risk of Bias Tool, out of 7 items of assessment, for item random sequence generation all three studies showed a low risk of bias, for item blinding of participants and personnel, blinding of outcome assessment, bias was unclear in all three studies, and in outcome data measures, all three studies were considered low risk (22, 23).

Comparison:

1. *Characteristics of studies (Table 3*): The demographic characteristics of participants: Age criteria in each study, were in common ranging around 61.4 ± 5.7; with both male and female in all studies in an average ranging of 1:1; with height and weight at a moderate level; with more of infarction type of cases than haemorrhage and more of right-side involvement than left. One study did not reveal detailed biological characteristic of participants. Stages of stroke varied for each study. More of chronic participant was seen in comparison to sub-acute stage. Inclusion criteria were, Cognition level evaluated with MMSE.
2. *Inclusion and exclusion factors and stage of stroke:* Scale with grades, 24-30 or participant should be able to understand command, should be ambulatory - to walk with or without support, and should be medically stable. For chronic stage participants in terms of 6 months to 2 years post stroke people were included. Exclusion criteria were participant with visual and hearing impairment, history of recurrent stroke, any other neurological condition or deficit, severe spasticity, and participant who underwent separate physical therapy treatment.
3. *Summary measures and synthesis of results:* This process measures type, duration, frequency, type of intervention, effects and outcome in the selected studies based on descriptive data collected from surveys, and reviews of clinical assessments.

a) *Duration and frequency*: Itis mentioned in each study in Table 3.

b) *Type of Pilate's intervention:* In study by Sathe *et al.,* type of exercises was more involved of core strengthening and perturbation with more of lower limb distal joint strategy. In a study by Surbala *et al.,* type of exercises were more involved Flexibility exercise, and Body alignment; In study by Lim *et al.,* type of intervention involved over Mat based Spine mobility and Upper and lower limb strengthening for training balance outcome.

c) *Effect of intervention and outcome*: As, the type of intervention differed in all the studies, its effects over balance training also varied between the studies. Outcome measured involves the characteristics required for balance in various aspects in each study, explained in Table 4.

Table 3: Demographic characteristics of population

Author	Study design	Population /Stage of stroke	Intervention group	Control group
Sathe *et al.,*	A randomized non-blinded controlled trial	Age, 64.7 ± 6.9 years/ both male and female stroke type: not mentioned paretic side: not mentioned chronic stage	n=5 conventional exercise with 18 Pilates exercise for 6 weeks (3 sessions / week)	n= 4 Conventional exercise for 6 weeks thrice weekly
Lourembam *et al.,*	An assessor-blinded, randomized controlled design	Age, 58 ± 5.2 years/ both male and female stroke type: hemorrhage: 0 ischemic: 23 paretic side: left side:16 right side :7 sub-acute stage	n=12 conventional therapy for 8 weeks with a series of 45- minute Pilates sessions thrice weekly	n=11 Conventional therapy for 8 weeks thrice weekly
Lim *et al.,*	A randomized controlled trial	Age, 64.7 ± 6.9 years/ both male and female stroke type: hemorrhage :9 ischemic: 10 paretic side: left side:11 right side :8 chronic stage	n=10 24 Pilates exercise sessions conducted over an 8-week period (3 sessions/week).	n= 9 No treatment was given.

Table 4: Correlation of Pilates exercise and its effects on post stroke impairments

Authors	Pilates exercise	Effect on stroke	Relevant outcome
Sathe *et al.,*	Core strengthening Perturbation with ankle and hip strategy	Increased trunk stability Increase in centre of gravity (COG)	Increased functional stability Reduced postural sway
Lourembam *et al.,*	Flexibility exercise Body alignment Slow precise sustained movements	Maintains center of mass over base of support Postural control Increased kinesthetic awareness of body in space	Increased dynamic balance Increased static balance Improved Proprioception
Lim *et al.,*	Mat based spine mobility upper and lower limb strengthening	Decreased center of pressure (COP) and sway velocity	Increased static and dynamic balance

DISCUSSION

This systematic review could not provide sufficient level of evidence, to highly recommend the intervention to overcome the outcome following stroke, as only small number of studies were available based on search criteria. Still the review provides some sorts of evidence that Pilates exercise would be beneficial in regaining outcome in patients with stroke, based on the RCT studies evaluated. During detailed study selection, some articles were excluded, as few studies were not focused on specific outcome and in some studies, exercise intervention was combined with other type of modalities (Table 1).

Table 4 illustrates the benefits of each type of Pilates exercise and its effects in improving post stroke outcome, both in sub-acute and chronic stage Outcome measures varied for each study, Table 5 illustrates, the outcome measures of each report from which data has been extracted. In the study of Lourembam *et al.,* outcomes functional balance and quality of life has significant change between patients who carried out Pilates exercise and those had conventional exercise (24). In Sathe *et al.,* study (7), balance is determined by variable limits of stability (LOS) which had significant change with patients who underwent Pilates study for components such as Reaction Time (sec), Maximum Excursion (%; 6). In the study, Lim *et al.,* showed that static and dynamic balance was improved in patients who underwent Pilates exercise than control group (25).

Table 5: Pilates exercise versus conventional

Outcome measures	Measures reported	P-value significant/ Non- significant	Study included
Limits of Stability (LOS)/ Tinetti Performance Oriented Mobility Assessment Scale (POMA	Reaction Time (sec) End Point Excursion (%) Maximum Excursion (%) Movement Velocity (degree/sec) Directional Control (%) POMA (points)	Significant Non-Significant Significant Non-Significant Non-Significant Significant	Sathe *et al.,*
Static and Dynamic balance/ Instrumented Treadmill with force plate	COP sway and velocity M- L COP range (mm) A- P COP range (mm) M-L COP velocity(mm/s) A-P COP velocity(mm/s)	Significant Significant Significant Significant	Lim *et al.,*
Functional balance and Quality of life	FRT TUG DGI SSSQL	Significant Significant Significant Significant	Lourembam *et al.,*

COP- centre of pressure, **BMI** - Body mass index; **FRT** - Functional reach test; **TUG** - Timed up and go test; **DGI** - Dynamic gait index; **SS-QOL** - Stroke specific quality of life scale A-P COP: anterior-posterior center of pressure; M-L COP: medio-lateral centre of pressure.

Strengths and limitations

Outcome measures have been highly varied between studies. In addition, studies failed to include the long-term follow-up, to assess any change in outcome. Due to large number of limitations and less no of relevant articles, strong conclusion was not possible. Future studies should be taken to address these limitations and can also concentrate on functional balance and quality of life, in stroke rehabilitation.

CONCLUSION

Pilates exercise showed significant changes in the studies taken into account. Although a smaller

number of studies cannot confirm the efficacy of Pilates exercise in improving post stroke balance. As the aim of this systematic review was to synthesize information on the effects of Pilates exercise and only a few articles were available to be said as valid sources of information in exploring different interpretations and perspectives, further study is expected, with this research question.

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CONFLICT OF INTEREST

No conflict of interest.

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