Introduction

Stroke is classically characterized as a neurological deficit and also neurological emergency attributed to an acute focal injury of the central nervous system (CNS) by a vascular cause, including cerebral infarction, intracerebral hemorrhage (ICH), and subarachnoid hemorrhage (SAH), and is a major cause of disability and death worldwide [1-3].

WHO definition of stroke (introduced in 1970 and still used) is “rapidly developing clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin. The recommended standard WHO Stroke definition is “a focal or global neurological impairment of sudden onset, and lasting more than 24 hours or leading to death and of presumed vascular origin” [4].

Clinical features as per vascular territory are as follows: In anterior cerebral artery infarct paresis or weakness of legs more than arm with sparing of hands, urinary incontinence, gait apraxia, and akinetic mutism are seen. In the middle cerebral...
artery infarct homonymous hemianopia, aphasia (Broca’s and Wernicke’s), inattention, gaze paralysis, and paresis of face-arm-leg are seen. In vertebrobasilar artery infarct if the occipital lobe is involved then symptoms like homonymous hemianopia, cortical blindness, and other cortical visual deficits are seen. If the cerebellum is involved then ataxia, and nystagmus are seen. If the brainstem is involved then cranial nerve palsies with diplopia, vertigo, dysphagia, and dysphonia are seen [5-10].

If a spinal tract is involved hemiparesis and hemisensory loss are seen. In lacunar stroke syndromes (due to occlusion of deep perforating small arteries) symptoms like pure motor hemiparesis, pure sensory stroke, sensorimotor stroke, and ataxic hemiparesis are seen [12-14].

Balance is the capability of maintaining the body’s center of gravity within the base of support. Balance activity is mediated by three systems: biomechanical, neurological, and sensory systems. Motor, sensory, and higher brain cognitive faculties to various degrees, which leads to diminished balance, more postural sway, and asymmetric weight distribution.

The novelty of perturbation training is in the focus on speed of processing and execution of limb movements, as well as rapid restabilization; this differs from ‘traditional’ balance training programs using voluntary movements that allow participants to control speed [15-19].

Virtual reality as a novel technology is rapidly becoming a popular intervention for improving balance and proliferated in the field of neurorehabilitation. Interactive multimedia technologies offer certain advantages over traditional rehabilitation treatments either due to accessibility issues, geography, or treatment availability, providing motivational activities, therapeutic adherence, and treatment compliance. In immersive VR we can visualize the computer-generated environments with a full field of view by Head-mounted displays (HMD-VR) [20-27]. This immersive virtual environment which represents a real environment can be used in balance training in which continuous visual feedback [28,29].

Virtual reality can be described in I³ terms: - INTERACTION + IMMERSION + IMAGINATION [30-53].

Conventional physical therapy based on activities of daily living skills includes active assistive exercises for the lower limb and upper limb, active exercises, functional retraining exercises, stretching, strengthening exercises, weight-bearing exercises, weight shifting exercises, reaching exercises in sitting and standing, and gait training.

**Aim of the study**

The aim of the study is to investigate the effect of balance exercises with smartphone-based virtual reality programs on balance in stroke patients.

**Research gap:** There are no gaps in knowledge or understanding of a subject. There is no lack of understanding of the mechanisms behind disease and how technology works.

**Hypothesis**

**Null hypothesis:** There may be no significant effects of balance exercises with smartphone-based virtual reality programs on balance in stroke.

**Alternate hypothesis:** There may be significant effects of balance exercises with smartphone-based virtual reality programs on balance in stroke.

Hence we accept the alternative hypothesis and reject the null hypothesis.

**Methodology**

The purpose of the study is to investigate the effect of balance exercises with a smart smartphone-based virtual reality program on balance in stroke patients.

**Method of collection of data**

Study design: Randomized single-group pre and post-test study design.

Sample size: 30

Sample design: Purposive sampling

Study duration: 12 months

**Source of data**

- Outpatient department and In-patient department of General Medicine in Kempegowda Institute of Medical Sciences Hospital and Research Centre, Bengaluru.

- Out-patient department of physiotherapy in Kempegowda Institute of Medical Sciences Hospital and Research Centre, Bengaluru.

- Out-patient department and inpatient department of neurology, and neurosurgery in Kempegowda Institute of medical science hospital and research center, Bengaluru.

**Sample size estimation**

- A sample size of an unknown population

\[
SS_{\text{eq}} = \frac{z^2 \times p(1-p)}{e^2}
\]

- **z value** - cumulative normal frequency

z = 1.96

- **p** - power of confidence

p = 0.05 (type I error)

- **e** - margin of error = 0.05
Effect of Balance Exercises with Smart Phone Based Virtual Reality Programme on Balance in Stroke Patients

Materials used:
1) Smartphone
2) Virtual reality- IRUSU MINI
3) IN CELL (game app)
4) Firm mattress
5) Foam mattress
6) Stopwatch
7) Measuring tape
8) Armrest Chair
9) Cones/markers

The subject included will be explained about the intervention in the language understood by the subject/family members. A signed informed consent will be obtained in the subject/family’s own understandable language Figure 1.

Data analysis
Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at a 5% level of significance.

The following are the assumptions of the data:
1) Dependent variables should be normally distributed,
2) Samples drawn from the population should be random, and Cases of the samples should be independent.

Statistical software
The Statistical software namely SPSS is used for the analysis of the data and Microsoft Word and Excel have been used to generate graphs, tables, etc Table 1.

Selection criteria
Inclusion criteria:
1) Patients with Ischemic stroke are diagnosed with a CT scan.
2) Stroke within 45 days.
3) A score of 26 points or higher on the Montreal Cognitive assessment
4) Both genders are included.
5) Subjects who are willing to participate, who have been explained and signed the written informed consent.

Exclusion criteria:
1) Subjects with Perceptual cognitive deficits like hemispatial neglect, attention, and memory deficit.
2) Subjects with Spinal and lower extremity deformities
3) Subjects with Terminal illness or medically unstable

SSkp = 72.990

SSkp = 2.5 for one month

Sample size = 12×2.417

Sample size = 29.004 ≈ 30

Therefore, the total sample size = 30

Selection criteria
Inclusion criteria:
1) Patients with Ischemic stroke are diagnosed with a CT scan.
2) Stroke within 45 days.
3) A score of 26 points or higher on the Montreal Cognitive assessment
4) Both genders are included.
5) Subjects who are willing to participate, who have been explained and signed the written informed consent.

Exclusion criteria:
1) Subjects with Perceptual cognitive deficits like hemispatial neglect, attention, and memory deficit.
2) Subjects with Spinal and lower extremity deformities
3) Subjects with Terminal illness or medically unstable

Materials used:
1) Smartphone
2) Virtual reality- IRUSU MINI
3) IN CELL (game app)
4) Firm mattress
5) Foam mattress
6) Stopwatch
7) Measuring tape
8) Armrest Chair
9) Cones/markers

The subject included will be explained about the intervention in the language understood by the subject/family members. A signed informed consent will be obtained in the subject/family’s own understandable language Figure 1.

Data analysis
Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at a 5% level of significance.

The following are the assumptions of the data;
1) Dependent variables should be normally distributed,
2) Samples drawn from the population should be random, and Cases of the samples should be independent.

Statistical software
The Statistical software namely SPSS is used for the analysis of the data and Microsoft Word and Excel have been used to generate graphs, tables, etc Table 1.
Outcome measures

The Montreal Cognitive Assessment (MoCA) is a tool that can be used to systematically and thoroughly assess cognitive and mental status. It is a 1-page, 30-point test, administrable in ≈10 minutes, which evaluates different domains: visuospatial abilities, executive functions, short-term memory recall, attention, concentration, working memory, language, and orientation to time and space. The total possible score is 30, a score of 26 or above is considered normal.

The Berg balance scale (BBS) was originally designed to quantitatively assess balance. The BBS is a 14-item scale that quantitatively assesses balance and risk for falls. The scale requires 10 to 20 minutes to complete and measures the patient’s ability to maintain balance either statically or while performing various functional movements— for a specified duration of time. The BBS measures both static and dynamic aspects of balance.

The timed up-and-go test (TUG) is an objective clinical measure for assessing functional mobility and balance, and thus the risk of falling. The TUG measures the time taken for an individual to rise from a chair, walk 3 meters, turn, walk back, and sit down using regular footwear and a walking aid if required. Subjects are asked to stand up from a standard chair with a height of between 40 cm and 50 cm, walk a 3 m distance at a normal pace, turn, walk back to the chair, and sit down.

The virtual reality balance error scoring system (VR-BESS) has improved the capability to detect lingering neurological and balance deficits. This involved 3 minutes of sitting followed by 3 minutes of standing while wearing

---

### Table 1: Data collection.

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Age</th>
<th>Gender</th>
<th>Berg Balance Scale (BBS)</th>
<th>Timed up and Go Test (TUG)</th>
<th>Virtual Reality Balance Error Scoring System (VR-BESS)</th>
<th>Balance Evaluation System Test (BESTest)</th>
<th>Stroke Impact Scale (SIS 3.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>51</td>
<td>Male</td>
<td>13</td>
<td>31</td>
<td>80</td>
<td>30%</td>
<td>75%</td>
</tr>
<tr>
<td>2)</td>
<td>55</td>
<td>Male</td>
<td>16.8</td>
<td>29</td>
<td>69</td>
<td>84</td>
<td>60%</td>
</tr>
<tr>
<td>3)</td>
<td>43</td>
<td>Male</td>
<td>12.14</td>
<td>30</td>
<td>75</td>
<td>83</td>
<td>75%</td>
</tr>
<tr>
<td>4)</td>
<td>66</td>
<td>Male</td>
<td>16</td>
<td>32</td>
<td>69</td>
<td>77</td>
<td>60%</td>
</tr>
<tr>
<td>5)</td>
<td>50</td>
<td>Male</td>
<td>17.12</td>
<td>33</td>
<td>64</td>
<td>76</td>
<td>40%</td>
</tr>
<tr>
<td>6)</td>
<td>55</td>
<td>Male</td>
<td>16.12</td>
<td>36</td>
<td>58</td>
<td>73</td>
<td>50%</td>
</tr>
<tr>
<td>7)</td>
<td>50</td>
<td>Female</td>
<td>12.14</td>
<td>30</td>
<td>75</td>
<td>83</td>
<td>75%</td>
</tr>
<tr>
<td>8)</td>
<td>66</td>
<td>Male</td>
<td>16.13</td>
<td>32</td>
<td>69</td>
<td>77</td>
<td>60%</td>
</tr>
<tr>
<td>9)</td>
<td>67</td>
<td>Male</td>
<td>16.14</td>
<td>30</td>
<td>75</td>
<td>83</td>
<td>75%</td>
</tr>
<tr>
<td>10)</td>
<td>74</td>
<td>Female</td>
<td>12.14</td>
<td>30</td>
<td>75</td>
<td>83</td>
<td>75%</td>
</tr>
<tr>
<td>11)</td>
<td>55</td>
<td>Male</td>
<td>16.14</td>
<td>29</td>
<td>69</td>
<td>84</td>
<td>60%</td>
</tr>
<tr>
<td>12)</td>
<td>75</td>
<td>Male</td>
<td>12.14</td>
<td>30</td>
<td>75</td>
<td>83</td>
<td>75%</td>
</tr>
<tr>
<td>13)</td>
<td>60</td>
<td>Female</td>
<td>12.14</td>
<td>30</td>
<td>75</td>
<td>83</td>
<td>75%</td>
</tr>
<tr>
<td>14)</td>
<td>66</td>
<td>Male</td>
<td>16.13</td>
<td>32</td>
<td>69</td>
<td>77</td>
<td>60%</td>
</tr>
<tr>
<td>15)</td>
<td>42</td>
<td>Male</td>
<td>12.14</td>
<td>30</td>
<td>75</td>
<td>83</td>
<td>75%</td>
</tr>
<tr>
<td>16)</td>
<td>51</td>
<td>Male</td>
<td>16.13</td>
<td>31</td>
<td>80</td>
<td>93</td>
<td>30%</td>
</tr>
<tr>
<td>17)</td>
<td>55</td>
<td>Male</td>
<td>16.13</td>
<td>29</td>
<td>69</td>
<td>84</td>
<td>60%</td>
</tr>
<tr>
<td>18)</td>
<td>50</td>
<td>Male</td>
<td>17.12</td>
<td>33</td>
<td>64</td>
<td>76</td>
<td>40%</td>
</tr>
<tr>
<td>19)</td>
<td>55</td>
<td>Male</td>
<td>16.12</td>
<td>36</td>
<td>58</td>
<td>73</td>
<td>50%</td>
</tr>
<tr>
<td>20)</td>
<td>51</td>
<td>Male</td>
<td>16.13</td>
<td>31</td>
<td>80</td>
<td>93</td>
<td>30%</td>
</tr>
<tr>
<td>21)</td>
<td>66</td>
<td>Male</td>
<td>16.13</td>
<td>32</td>
<td>69</td>
<td>77</td>
<td>60%</td>
</tr>
<tr>
<td>22)</td>
<td>50</td>
<td>Male</td>
<td>17.12</td>
<td>33</td>
<td>64</td>
<td>76</td>
<td>40%</td>
</tr>
<tr>
<td>23)</td>
<td>55</td>
<td>Male</td>
<td>16.12</td>
<td>36</td>
<td>58</td>
<td>73</td>
<td>50%</td>
</tr>
<tr>
<td>24)</td>
<td>51</td>
<td>Male</td>
<td>16.13</td>
<td>31</td>
<td>80</td>
<td>93</td>
<td>30%</td>
</tr>
<tr>
<td>25)</td>
<td>55</td>
<td>Male</td>
<td>16.13</td>
<td>29</td>
<td>69</td>
<td>84</td>
<td>60%</td>
</tr>
<tr>
<td>26)</td>
<td>50</td>
<td>Male</td>
<td>17.12</td>
<td>33</td>
<td>64</td>
<td>76</td>
<td>40%</td>
</tr>
<tr>
<td>27)</td>
<td>55</td>
<td>Male</td>
<td>16.12</td>
<td>36</td>
<td>58</td>
<td>73</td>
<td>50%</td>
</tr>
<tr>
<td>28)</td>
<td>51</td>
<td>Male</td>
<td>16.13</td>
<td>31</td>
<td>80</td>
<td>93</td>
<td>30%</td>
</tr>
<tr>
<td>29)</td>
<td>55</td>
<td>Male</td>
<td>16.13</td>
<td>29</td>
<td>69</td>
<td>84</td>
<td>60%</td>
</tr>
<tr>
<td>30)</td>
<td>66</td>
<td>Male</td>
<td>16.13</td>
<td>32</td>
<td>69</td>
<td>77</td>
<td>60%</td>
</tr>
</tbody>
</table>
the VR headset and experiencing the rollercoaster stimulus attempting to maintain balance in a two-leg, single-leg, or tandem stance on both foam and firm surface for 20 seconds in each stance Figure 2,3.

The Balance Evaluation System Test (BESTest) is a new tool that assesses different balance systems including biomechanical constraints, stability limits/verticality, anticipatory postural adjustments, postural responses, sensory orientation, and gait stability. It is divided into 27 tasks and 6 subgroups, each item is scored on a 4-level, ordinal scale from 0 (worst performance) to 3 (best performance). The total score for the test is 108 points.

The Stroke impact scale (SIS) 3.0 assesses 59 items of a patient’s quality of life, divided into eight dimensions where a stroke has an overall effect on health and well-being. After SIS is administered, the respondent is asked to rate their percent recovery since their stroke on a visual analog scale of 0 to 100 with 0 meaning no recovery & 100 meaning full recovery Figure 4.

**Intervention**

**Perturbation-based balance training:**
- Perturbations were given in the sitting position on a couch and standing positions, with 10 10-second hold, 10 perturbations in each position, and 5 minutes.
- Perturbations were given in both right and left sideways forward and backward directions in sitting and standing.
- Perturbations were given at the shoulder, trunk and waist region.

**Smartphone-based virtual reality training:**
- The therapist explains the neurorehabilitation program based on perturbation-based balance exercise with a head-mounted display virtual reality (IRUSU MINI) with a smart smartphone enclosed in it with the game “IN CEEL VR” and demonstrates the game by showing a screen recording how to play.
- IN CELL VR game is an action racing VR game with a bit of strategy and science thrown into the mix. It will take an exciting journey inside the highly unusual micro world of human cells and stop the virus's advance.
- IN CELL VR game that has specific tasks like hitting the proteins and avoiding the viruses. The subject had to hit the protein and avoid the viruses, which was done in a standing position Figure 5.

**Results**

**Interpretations**

**Interpretation:** The above Table 2 and Figure 6 show the mean and standard deviation of age. Subjects studied a mean of 56.367 and a standard deviation of 8.29.

**Interpretation:** Using t-statistics and a 5% level of significance. The critical value for the test with df=29 and alpha = 0.05 is 2.045 and the decision rule is to Reject null if the t-value is greater than are equal to 2.045. i.e., calculated value >= critical value Table 3.
The result showed a significant difference in Berg balance scale scores within the group \((p = 0.00)\). Hence, we reject the null hypothesis and accept the alternative hypothesis that smartphone-based virtual reality balance training with perturbation-based balance training has a significant effect on stroke.

**Interpretation:**

Using \(t\)-statistics and a 5% level of significance. The critical value for the test with \(df=29\) and \(alpha = 0.05\) is 2.045 and the decision rule is to Reject null if the \(t\)-value is greater than are equal to 2.045. i.e., calculated value \(>=\) critical value Table 6.

Calculated value \(= 12.867\) and critical value \(= 2.045\).

Hence, we reject null \((H0)\) because \(12.867 \geq 2.045\) and \(p < 0.05\). We have statistically significant evidence at alpha \(= 0.05\) to show there is a difference in the mean of the virtual reality balance error scoring system on day 1 and the day 4th week.

• The result showed a significant difference in Virtual reality balance error scoring system scores within the group \((p = 0.00)\). Hence, we reject the null hypothesis and accept the alternative hypothesis that smartphone-based virtual reality balance training with perturbation-based balance training has a significant effect on stroke.

**Interpretation:**

Using \(t\)-statistics and a 5% level of significance. The critical value for the test with degree of freedom and alpha = 0.05 is 2.045 and the decision rule is to Reject null if the \(t\)-value is greater than are equal to 2.045. i.e., calculated value \(>=\) critical value Table 5.

Calculated value \(= 12.867\) and critical value \(= 2.045\).

Hence, we reject null \((H0)\) because \(12.867 \geq 2.045\) and \(p < 0.05\). We have statistically significant evidence at alpha \(= 0.05\) to show there is a difference in the mean of the Timed up and Go test on day 1 and the day 4th week.

• The result showed a significant difference in Timed up-and-go test scores within the group \((p = 0.037)\). Hence, we reject the null hypothesis and accept the alternative hypothesis smart phone-based virtual reality balance training with perturbation-based balance training has a significant effect on stroke.

**Interpretation:**

Using \(t\)-statistics and a 5% level of significance. The critical value for the test with degree of freedom and alpha = 0.05 is 2.045 and the decision rule is to Reject null if the \(t\)-value is greater than are equal to 2.045. i.e., calculated value \(>=\) critical value Table 5.

Calculated value \(= 12.867\) and critical value \(= 2.045\).

Hence, we reject null \((H0)\) because \(12.867 \geq 2.045\) and \(p < 0.05\). We have statistically significant evidence at alpha \(= 0.05\) to show there is a difference in the mean of the Timed up and Go test on day 1 and the day 4th week.

• The result showed a significant difference in Berg balance scale scores within the group \((p = 0.00)\). Hence, we reject the null hypothesis and accept the alternative hypothesis that smartphone-based virtual reality balance training with perturbation-based balance training has a significant effect on stroke.

**Interpretation:**

Using \(t\)-statistics and a 5% level of significance. The critical value for the test with degree of freedom and alpha = 0.05 is 2.045 and the decision rule is to Reject null if the \(t\)-value is greater than are equal to 2.045. i.e., calculated value \(>=\) critical value Table 4.

Calculated value \(= 14.586\) and critical value \(= 2.045\).

Hence, we reject null \((H0)\) because \(14.586 \geq 2.045\) and \(p < 0.05\). We have statistically significant evidence at alpha \(= 0.05\) to show there is a difference in the mean of the Berg Balance Scale on day 1 and the day 4th week.

• The result showed a significant difference in Berg balance scale scores within the group \((p = 0.00)\). Hence, we reject the null hypothesis and accept the alternative hypothesis that smartphone-based virtual reality balance training with perturbation-based balance training has a significant effect on stroke.

**Interpretation:**

Using \(t\)-statistics and a 5% level of significance. The critical value for the test with degree of freedom and alpha = 0.05 is 2.045 and the decision rule is to Reject null if the \(t\)-value is greater than are equal to 2.045. i.e., calculated value \(>=\) critical value Table 4.

Calculated value \(= 2.191\) and critical value \(= 2.045\).
Effect of Balance Exercises with Smart Phone Based Virtual Reality Programme on Balance in Stroke Patients

Table 5: An Assessment of Virtual Reality Balance Error Scoring System Variables at pre and post measurements of patients.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Score</td>
<td>31.533</td>
<td>2.193</td>
</tr>
<tr>
<td>Post-Score</td>
<td>21.267</td>
<td>5.9069</td>
</tr>
<tr>
<td>Difference</td>
<td>10.266</td>
<td>3.7139</td>
</tr>
</tbody>
</table>

$p$ - value (within the group) - paired $t$ - test < 0.05** ($t = 12.867$)

Table 6: An Assessment of Balance Evaluation System Test variables at pre and post-measurement of patients.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Score</td>
<td>70.1</td>
<td>6.9597</td>
</tr>
<tr>
<td>Post-Score</td>
<td>81.567</td>
<td>6.4844</td>
</tr>
<tr>
<td>Difference</td>
<td>11.467</td>
<td>0.4753</td>
</tr>
</tbody>
</table>

$p$ - value (within the group) - paired $t$ - test < 0.05** ($t = -20.604$)

Calculated value = 20.604 and critical value = 2.045.

Hence, we reject null (H0) because 20.604 >= 2.045 and $p < 0.05$. We have statistically significant evidence at alpha = 0.05 to show there is a difference in the mean of the Balance Evaluation System test on day 1 and the day 4th week.

- The result showed a significant difference in the Balance evaluation system Test scores within the group ($p = 0.00$). Hence, we reject the null hypothesis and accept the alternative hypothesis that smartphone-based virtual reality training with perturbation-based balance training has a significant effect on stroke.

Interpretation: Using t-statistics and a 5% level of significance. The critical value for the test with degree of freedom and alpha = 0.05 is 2.045 and the decision rule is to Reject null if the $t$ - value is greater than are equal to 2.045. i.e., calculated value >= critical value Table 7.

Calculated value = 8.36 and critical value = 2.045.

Hence, we reject null (H0) because 8.36 >= 2.045 and $p < 0.05$. We have statistically significant evidence at alpha = 0.05 to show there is a difference in the mean of the Stroke impact on day 1 and the day 4th week.

- The result showed a significant difference in SIS scores within the group ($p = 0.00$). Hence, we reject the null hypothesis and accept the alternative hypothesis that smartphone-based virtual reality balance training with perturbation-based balance training has a significant effect on stroke.

Limitations of the study

1. The sample size was small, limiting the generalizability of the results.
2. The age group was kept wide due to the unavailability of sample size.
3. Only sub-acute stroke patients were included.

4. Study duration was short i.e., only for 4 weeks.
5. The study analyzed only the short-term benefits with respect to mobility, balance, and function.

Future scope and suggestions

1. Future clinical trial studies can be carried out on a large sample size.
2. A similar study can be conducted in patients with different neurological conditions like Parkinson’s, and cerebral palsy.
3. In the present study improvement in balance, and postural control was seen in sub-acute stroke patients, so future studies can also be done to see the effect of perturbation-based balance training on all phases of stroke patients i.e., in acute and chronic.
4. Further studies are needed to investigate the long-term effects of mobile-based virtual reality programs along with conventional physiotherapy treatment balance, and postural control.

Conclusion

Stroke is the leading cause of disability and frequent falling is one of the complications of post stroke. Impaired postural control and balance are associated with a high incidence of falls in stroke. Incidence of fall in stroke, balance exercises is essential.

This study was conducted to find the effect of perturbation-based balance exercises with smartphone-based virtual reality along with conventional physiotherapy. After four weeks of intervention, Berg balance scale (BBS), timed up and go test (TUG), virtual reality balance error scoring system (VR BESS), balance evaluation system test (BESTest), stroke impact scale 3.0 (SIS 3.0) were used to analyze the data, results of data analysis showed significant improvement in lower extremity function, balance, gait speed, functional ability, postural stability, muscular coordination, mobility and fall risk.

The findings provide a new paradigm of training guidelines for balance control and can reduce the risk of falling. This perturbation-based balance training with a smartphone-based virtual reality program appears to be feasible and effective for improving balance after ischemic stroke. The findings from our study are clinically important, as they provide an innovative method for the treatment of stroke patients with an efficient, safe, and low-cost program.
References


Effect of Balance Exercises with Smart Phone Based Virtual Reality Programme on Balance in Stroke Patients


