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Research Article

COMPARISON BETWEEN VIRTUAL REALITY TRAINING USING X-BOX 360 KINECT AND CONVENTIONAL PHYSIOTHERAPY ON TRUNK, POSTURAL CONTROL AND QUALITY OF LIFE IN CHRONIC STROKE SURVIVALS

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A B S T R A C T

Background and Purpose: Virtual reality using commercial gaming devices has been recognized a promising tool to induce functional recovery after lesions followed by stroke. But evidences were more focused on upper extremity, mobility and gait but less on postural control in stroke patients. Therefore the purpose of the study was to explore the effect of X Box 360 kinect on trunk, postural control and quality of life in stroke rehabilitation.
Objective: was to compare the effect of VR using X Box 360 Kinect and conventional therapy (CT) on trunk and postural control in terms of sitting limit of stability, maintaining and changing posture and quality of life (QOL).
Methods: The experimental study on chronic patients at neurophysiotherapy department. 28 participants fulfilling inclusion criteria, allotted in Virtual group (Group A, n=15) and Conventional group (Group B, n=13). Group A was trained using X BOX 360 kinect for 6 weeks (30mins/day, 3 days/week). CT group underwent mobility, balance and trunk specific exercises for same period. Pre and post intervention Trunk impairment scale (TOS) for trunk control, sitting limit of stability (LOS), Postural assessment scale (PASS) for postural control and stroke specific QOL (SSQOL) for QOL analyzed for both groups.
Results: Both the groups showed significant ($P<0.05$) improvement in all outcome measures. Group A showed significantly more improvement compared to Group B($P<0.05$) in dynamic component of TIS, maintaining and changing posture components ($P<0.05$), reaction time and movement velocity ($P<0.05$) components of LOS. There was no significant difference in end point excursion, maximum end point excursion and directional control between the groups.
Conclusion: VR training using X box 360 found significantly more effective on trunk, postural control and Quality of life in chronic stroke patients compared to conventional physiotherapy. Therefore this cost-effective, Kinect friendly technique can be used in rehabilitation.

INTRODUCTION

As the world is moving towards technology, Rehabilitation field is also showing many studies with use of technologies. One of such Novel technologies that has entered into the field of neurorehabilitation in 21st centuryis Virtual reality[1]

Virtual reality is nothing but the term used to describe three-dimensional, computer generated environment which can be explored and interacted with by a person and that person becomes part of this virtual world or is immersed within this environment and whilst there, is able to manipulate objects or perform a series of actions [2].

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VR can be provided by different systems which are available in today's market but VR provided by video games are found less expensive, such as wii or playstation, X-BOX 360 Kinect [3]. The X-BOX 360 kinect which is Microsoft resealed on AVG console-kinect come in market of virtual reality in 2010, which is commercial video game system provides full body control of animated virtual character in which is noninvasive VR technique to encourage people with motor disabilities to exercise repeatedly and actively in real environment [4,5,6,7,8,9]. Kinect enables users to control and interact with the game console without the need to touch a game controller, through a natural gesture-based user interface. The device comes with an RGB camera and a depth sensor, which in combination provides full- body three-dimensional motion capture capabilities and gesture recognition [2,4,5] . X- BOX Kinect has

different monitoring than other computer based games using joysticks and controller.

This VR technique is used in many neurological conditions as virtual reality provides patients with real environment .Evidence is available in conditions like Multiple sclerosis, Parkinsonism, Cerebral palsy, autism and SCI etc, where it shows improvement in eye hand coordination in case of CP, improve gait and postural instability in case of parkinsonism, sitting balance in case of SCI, Behavioural changes in case of autism[10, 11, 12, 13].

There are also many studies which show results of virtual reality training effects on stroke patients [1]. Most of which are emphasizes on upper extremity, standing balance, Gait. Effect of VR on upper extremity is proved by showing improvement in fugl mayer scale, wolf scale, it also shows improvement on bergs balance scale as well in case of Gait it shows improvement on different parameters of gait [2,14,15,16,17].

Stroke is the leading cause of death and disability all over the world. The worldwide prevalence was reported to be 33 million in 2010 [18, 19, 20]. Patient with stroke often shows motor, cognitive, perceptual, visual, sensory or psychomotor disabilities Overall effect of theses impairment limits postural control and motor function and mobility as well as causes disturbances in maintaining balance[14,21,22,23]. Hemiplegic causes increase in postural instability, asymmetrical weight bearing, impairment of body weight transfer capabilities and decrease in maintaining postural ability[14, 23].Training of upper extremity and Gait is important part of rehabilitation, but good trunk control is mandatory to improve function. Trunk plays an important function in individual of providing a mobile, but yet stable support so that extremities can conveniently position for their skilled work.

Trunk maintains upright posture against gravity, adjust weight shifts and perform selective movements of the trunk that maintains the base of support during static and dynamic postural adjustments[24, 25, 26, and 27]. The two groups of muscles chiefly responsible for moving or controlling the trunk are the back extensors and the muscles which forms abdominal wall, because of their mechanical arrangement and their multiple segmental innervations, the abdominal muscles have peculiar property, unlike most other muscles in the body, are able to contract in part and not just as whole, provides various movements to trunk and postures and provides stable anchorage for the muscles which acts on head, shoulder and hip. The efficient action of the muscles of one side of the abdominal wall is therefore very much dependent upon the fixation or anchorage provided by the activity of the muscles on the other side, particularly for the activities involving rotation of the trunk. Rotation of the trunk is performed by oblique abdominal muscles. The activity is not unilateral, but requires the static holding of the contra lateral muscles to stabilize the aponeurosis, so allowing the agonists to shorten and draw one side of the pelvis or thorax forward.The muscles act on the trunk has plays three main important functions: 1) Movement in a direction opposite to the pull of gravity, 2) Preventing movement which would otherwise take place a result of the pull of gravity of other forces acting upon the body, 3) Controlling the speed of the movement taking place as a result of the pull of gravity[28].

Evidence shows that Trunk control is the early predictor of functional recovery post stroke[29]. Although the stroke affects unilateral limb activity, it has a potential to deteriorate the function of trunk muscles on both sides of the body affecting the proximal control. The lack of proximal stabilization influences the limbs severiouly, result of which arm and leg can only be moved in spastic synergy patterns. In an attempt to move upright against gravity, this loss of fixation which is compensated by increased distal spasticity. Post stroke, there is a Loss of selective activity in muscle groups of trunk which enables patient to stabilize his/her thoracic spine in extension while using lower abdominals in isolation, which is reflected in walking. There are evidences which focuses on different assessment method of trunk control which shows that, post stroke, there is a weakness of bilateral trunk flexors, extensors and rotator muscles in both acute and chronic hemiplegic patients when assessed by iso-kinetic and handheld dynamometer, EMG assessment shows that poor bilateral trunk muscles activity in patients with stroke, Trunk impairment scale which is a sensitive tool to evaluate the selective muscle control of upper and lower trunk, which also showed lateral flexion of the trunk is easier than rotation of the trunk[28,30].

Evidence is available which state that "Good trunk control and limit of stability is required to maintained Postural control in chronic stroke patients." Post stroke trunk control gets affected result of which, Postural orientation and equilibrium is also get affected, which is required to fix the orientation and position of the segments that serve as a reference frame for perception and action with respect to the external world[24,25,26,27,29]. There are many studies which show trunk control exercises are important to improve postural control with different conventional approaches like Brunnstrom, PNF, NDT etc[31, 32, and 33]. Hence it shows that Trunk control and postural control training has been given importance in conventional therapy.

Stroke required long term rehabilitation where patient compliance is very important for successful outcome in rehabilitation program .Along with Conventional therapy which include mobility, strengthening, balance and gait enhancing exercises using different approaches were most widely used till 20th century, use of VR technology is also gaining popularity[1, 31.]

Most studies using virtual reality using video games have focused on more on more on hand function, gait [34,] but there are limited evidences using only VR technology targeting trunk control and postural control. Evidences also shows that VR has many advantages of providing patient real environment and motivation to practice.[14, 58].

very few studies are done purely using X-BOX 360 Kinect as a only to elucidating on Postural and trunk control thereby on mobility and quality of life in subacute and chronic stroke survivals [17, 35, 36] .Therefore this study is aimed to determine the effect of virtual reality using X-BOX 360 Kinect on Postural control and quality of life using x box 360 kinect and given different games like tennis, skiing, darts, golf and baseball.

MATERIALS AND METHOD

Materials Used in Study

1. Neurocom's balance master system.
2. Customized wooden table.

3. Measuring tape
4. X box 360 console and kinect
5. Screen to display.
6. Trunk Impairment scale.
7. Postural Assessment Scale.
8. Stroke specific quality of life (SSQOL) Scale.

METHOD AND METHODOLOGY

Study design-Experimental study design.
Study Setup-D.Y.Patil physiotherapy department (Navi Mumbai)
Sampling Method- Convenient sampling.
Sample size-28 (VR training-15, Conventional-13)
Duration of study-one year

Methodology

This study was performed in setup of D.Y.Patil physiotherapy Department on patients who are in a category of chronic stroke i.e. Patient who has been suffering from stroke from last 6 months. Pilot study was performed on 5 chronic stroke patients before beginning with actual study. Sample size was estimated from the mean and standard deviation of data of pilot study by the statistician.

Potential participants were eligible if they

Inclusion Criteria

1. they had stroke from past 6 months,
2. mini mental score of 24 or higher,
3. Participants having Brunnstrom stages 3, 4 and 5.
4. Participants having spasticity on MODIFIED ASHWORTH SCALE less than grade 2 for the upper extremity muscles.
5. Can sit for at least 30 minutes without support.
6. Can provide informed consent.
7. No known visual, auditory and disorder.

Exclusion Criteria

1. Participants have an unstable cardiovascular, respiratory, endocrine, orthopedic or neurological condition that precludes exercise of low to moderate intensity,
2. Vestibular deficits or vertigo.
3. No history of seizures.
4. Aphasia and aphasia of speech are not absolute exclusion criteria, but potential participants must be deemed able to learn VRT in order to participate.

In this study Potential 28 candidates were selected depending upon above inclusion criteria.

They were placed into two different groups,

Group A participants has given virtual reality training and
Group B has given conventional physiotherapy.

15 participants were placed in group A who were ready to come for afternoon session and remaining in group B who comes in morning OPD session. In group A, Participants having (11-left side and 4 –right side) stroke, (Male-12 and Female-3), Ranging from age group 18 to 60 years were placed. In group B, 13 participants were placed, having (8 left and 2 right side) stroke, (Male-11 and Female-2), Ranging from age group 18 to 60 years. Both the groups' potential participants are informed of study details, including procedures, risks and benefits, confidentiality and the voluntary nature of participation, before signing the consent form.

Group A and Group B, were assessed pre and post study with following outcome measures.

1. Mini-Mental Scale.
2. Trunk Impairement Scale.
3. Limit of Stability.
4. Postural Assessment Scale for Stroke.
5. Stroke Specific Quality of Life.

In group A, participants were exposed to following games depending upon their current trunk control and postural control. Participants with low trunk control and low PASS scale were given games in sitting position on wooden table which has wide base and appropriate height with respect to screen and progress to standing after 2 weeks with putting belt against trunk to maintain balance while playing. having trunk and postural control at least to the mark that they maintain standing without support for 1 minute are progress to standing games 1 week after sitting games. Sessions are conducted for half an hour, 3times a week for 6 weeks.Pre sessions and post sessions all the vitals are checked in every session. Participants are given instructions about every game and given one demo of every game for 5 minutes. Before starting any new game. Participants are instructed to stop session any time if they feel fatigue or stop by therapist if any abnormal signs have observed. Following games have been performed with increasing difficulty level.

Table no 1 Game Description

Name of Game	Description of game	Subjects position while playing game
1)Tennis	Participant have to hold imaginary racket in involved hand with the help of non involved hand, if not possible therapist guide involved hand and participant move body in all direction in order to hit the ball.	Sitting progress to standing after 2 weeks with trunk belt.
2)skiing	This game is performed in snow with two red or two blue gates which participant have to cross in order to avoid imaginary hit and move in all directions to cross gates which are on particular intervals. Participant has to move their body forward-backward to speed up in race.	Sitting progress to standing after 2 weeks, performed with trunk belt in standing.
3)Dart	In this game participant puts involved leg ahead and put dark on mark, by moving forward with involved hand with help of other hand.	Sitting, then progress in transition from sit to stand and then in standing with involved leg ahead with trunk belt for safety.
4)**Golf**	In this game, participant asked to stand one side with paretic side towards screen and hit ball with involved hand with help of other hand. Ask the participant to move ball in hole.	Standing on one side with trunk belt for safety.
5.**Baseball**	In this game, participant has to perform two rolls one is bawler and one is batsman. In one participant has to lean forward and throw ball with involved side and other is hit ball with involved hand with help of non paretic hand and move leg up and down in order to take runs.	Standing straight for balling and on involved side when bating with trunk belt for safety.

In group B, participants were treated by regular conventional therapy which included mobility exercises, facilitating movement control of limbs and trunk. Trunk specific exercises like bridging, trunk rotation in lying and sitting, reach outs in different directions on plinth progressed to physio ball as well as in standing positions Group B subjects were also called for half an hour session, 3 times a week for 6 sessions. At the end of study both groups were assessed by above outcome measure and comparison is done in their pre and post study outcome measures difference in between VR GROUP (A) and Conventional physiotherapy group (B) in order to see trunk control and postural control is better in which group and which group has induce quality of life or both groups have same impact on postural control and quality of life. The experimental results were statistically analyzed using Graph Pad InStat version 3.1 and graphs were made in MS-EXCEL Sheets.

Data Analysis and Interpretation

A total 28 subjects were enrolled for the study (VR GROUP-15 and Conventional-13).The age of population in both groups was ranged between Group A-48.9±10.65, -Group B - 50.38±8.08]. In l group A out of 15 total samples 13 were male and 3 were female. In group B out of 13 total samples 11 were male and 2 were female. The effect of Virtual reality using X BOX 360 Kinect on postural control and SSQOL Was calculated and entered in MS-EXCEL 2007.It was analyzed using the GRAPHPAD INSTAT VERSION 3.1 and graphs were made in MS-EXCEL sheets. Before beginning with analysis, Pre intervention, baseline characters like Age, duration of onset, TIS, PASS, LOS component, SSQOL, of both groups were matched using statistical tests. After intervention of 6 weeks, post test TIS, PASS, LOS components (RT, MV, EPE, MXE, DC), SSQOL were again analyzed for significant difference.

Further comparison of sub components of TIS i.e. Static, Dynamic and Co-ordination was done between the two groups. Similarly Components of PASS i.e. maintaining and changing posture were also compared between two groups. The data was analyzed for its homogeneity across groups. For the data fulfilled criteria, parametric test were used and for the data did not fulfill these criteria Non Parametric tests were used. Accordingly Paired t-test was used for within group comparison and unpaired t test or Mann –Whitney test were used for between groups comparison.

Table No 2 Demographic Data

Title	GROUP A	Group B	P Value
Age	48.9±10.65	50.38±8.08	0.69
Gender	12 Males And 3 Females	11 Males 2 Females	-
Duration of Onset	3.06±2.49	3±1.732	0.93
Side of lesion	Left-9,Right-6	Left-9,Right-4	-
Pre Intervention trunk Impairement scale	10.71±3.26	12.84±2.47	0.069
Pre Intervention Postural Assessment Scale	16±5.60	16.46±3.59	0.80
Pre Intervention Ssqol	148.86±21.27	160.±25.077	0.21
Pre Intervention Reaction time of los	1.31±0.34	1.27±0.30	0.79
Pre Intervention mov velocity of los	3.5±1.36	3.91±0.99	0.37
Pre Invervention end Pt Excursion	80.73±15.36	86.76±13.89	0.288
Pre Intervention Maximum Excursion	100.86±12.80	104.76±4.74	0.309
Pre Intervention Directional Control	80.06±6.97	75.84±7.84	0.14

***Significance level P <0.05**

Interpretation-Both the groups did not show any significant difference in baseline characters

Table 3 Comparison between Pre and Post Intervention Improvement in Trunk Impairment Scale Within Group A And Group B.

Title	pre		Post		P Value
	Mean±SD	Lower-Upper 95% Conf.LIMIT	Mean±SD	Lower-Upper 95% Conf.Limit	
Group A	10.71±3.7	8.40-12.25	19.6±1.6	18.62-20.57	0.0001*
Group B	12.84±2.7	11.34-14.34	17.92±2.06	16.67-19.16	0.0001*

* Significance level P <0.05

Interpretation-When the TRUNK IMPAIREMENT SCALE FOR PRE AND POST VR training as well as PRE AND POST conventional training, compared using paired t test respectively, two tailed P value is < 0.0001, considered extremely significant.

Table No 4 Comparison Between Pre And Post Interventtion Improvement In Postural Assessment Scale Within Group A And Group B.

Title	PRE		POST		P Value
	Mean±SD	Lower-Upper 95% Conf.Limit	Mean±SD	Lower-Upper 95% CONF.LIMIT	
Group A	16±5.60	12.89-19.10	30.8±3.91	28.63-32.96	0.0001*
Group B	16.46±3.59	14.28-18.63	22±2.48	20.49-23.50	0.0001*

*** Significance level P <0.05**

Interpretation-When the Postural Assessment Scale Score for Pre And Post VR training as well as PRE AND POST conventional training, compared using paired t test respectively, two tailed P value is < 0.0001, considered extremely significant.

Table No 5 Comparisons between Pre and Post Intervention in Stroke Specific Quality Of Life within Group A And Group B

Title	Pre		Post		P VALUE
	Mean±SD	Lower-Upper 95% CONF.LIMIT	Mean±SD	lower-upper 95% conf.limit	
Group A	148.8±21.2	137.01-160.6	197.8±20.64	186.3-209.2	0.0001*
Group B	160±25.07	144.8-175.1	180.69±25.44	165.3-196.0	0.0001*

*** Significance level P <0.05**

Interpretation- When the STROKE SPECIFIC QUALITY OF LIFE SCORE FOR PRE AND POST VR training as well as PRE AND POST Conventional training, compared using paired t test respectively, two tailed P value is < 0.0001, considered extremely significant.

Table No 6 Comparison Between Post Intervention Improvement In Tis, Pass And Ssqol In Chronic Stroke Patients.

TITLE	GROUP A (MEAN±SD)	GROUP B (MEAN±SD	P VALUE
TIS	9.33±2.58	5.07±2.25	0.0001*
PASS	14.13±2.53	5.69±3.27	0.0001*
SSQOL	48.93±14.70	20.69±10.11	0.0001*

*** Significance level P <0.05**

Interpretation- When Post intervention Trunk Impairement Scale Score for Group A and Group B is compared using unpaired t test, two tailed P value is <0.0001, considered extremely significant.

When Post intervention Postural Assessment Scale Score for Group A and Group B is compared using unpaired t test, two tailed P value is <0.0001, considered extremely significant.

When Post intervention, the Stroke Specific Quality Of Life Scale Score for Group A and group B were compared, using Non Parametric Mann-Whitney test, two tailed P value is < 0.0001, considered extremely significant.

Table No 7 Comparison Between Improvement In Static, Dynamic, Co-Ordination Component Of Tis Between Group A And Group B

Title	Static(Diffence)		Dynamic(Difference)		Co-Ordination(Difference)	
	Mean±SD	Lower-Upper 95% Conf.Limit	Mean±SD	Lower-UPPER 95% Conf.Limit	Mean±SD	Lower-Upper 95% Conf.Limit
Group A	1.4±1.83	0.74-2.05	4.93±1.58	4.05-5.8	2.66±1.11	2.05-3.28
Group B	1.0±0.81	0.50-1.49	2.07±1.88	1.35-2.7	2.23±0.92	1.67-2.79
P Value	0.431*		0.0001*		0.184*	

*** Significance level P <0.05**

Interpretation-When the Static, dynamic and co-ordination component of TIS are compared between Group A and Group B respectively using Mann-Whitney Non Parametric ANOVA test, for static and coordination component P value >0.0001,considered not significant, For Dynamic TIS,P value <0.0001,considered extremely significant

Table No 8 Comparison Between Improvement In Maintaing Posture And Changing Posture Of Pass Between Group A And Group B.

Title	Maintaing Posture(Difference)		Changing Posture(Difference)	
	Mean±SD	Lower-Upper 95% Conf.Limit	Mean±SD	Lower-Upper 95% Conf.Limit
Group A	6.86±1.45	6.06-7.67	7.93±1.43	7.13-8.73
Group B	1.69±0.85	1.17-2.20	3.07±1.84	1.96-4.19
P Value	0.0001*		0.0001*	

*** Significance level P <0.05**

Interpretation-When the Maintaining and changing posture of PASS between Group A and group B is compared using unpaired t test respectively, two tailed P value is < 0.0001, considered extremely significant.

Table No 9 Comparison between Reaction Time of Limit of Stability between Group A And Group B.

Title	Mean±SD	Lower-Upper 95% Conf.Limit	P Value
GROUP A	0.67±0.37	0.46-0.887	0.392
GROUP B	0.3±0.33	0.12-0.48	0.3

*** Significance level P <0.05**

Interpretation- When the Reaction Time of Limit of Stability Score for Group A and group B were compared, using unpaired t test two tailed P value is < 0.0001,considered extremely significant

Table No-10 Comparison between Movement Velocity of Limit Of Stability Between Group A And Group B.

Title	Mean±SD	Lower-Upper 95% Conf.Limit	P Value
Group A	3.79±1.52	2.99-4.91	0.0001*
Group B	2.06±0.93	1.49-2.62	0.0001*

*** Significance level P <0.05**

Interpretation- When the MOVEMENT VELOCITY OF LIMIT OF STABILITY Score for VR training and conventional group were compared, using unpaired t test two tailed P value is < 0.0001, considered extremely significant.

RESULTS

In current study,28 chronic stroke patients were taken. In GROUP A(VR group) 15 patients were taken treated with virtual reality and GROUP B(conventional group) 13 patients were treated with conventional therapy. At the end of 6 weeks ,TIS,PASS,SSQOL and LOS were re-evaluated and results were as follows:-

Intergroup Comparison

By applying paired t-test for group A

1. The mean value of pre TIS was 10.71±3.7 and after VR therapy of 6 weeks the TIS value post was 19.6±1.6. The mean difference was 8.89.t value was 14.24 and standard error of difference was 0.650. The two tailed p-value 0.0001. Significant improvement in TIS was seen after training with VR in group A.
2. The mean value of pre PASS was 16±5.60 and after VR therapy of 6 weeks the PASS value post was 30.8±3.91. The mean difference was 14.8.t value was 21.40, standard error of difference was 0.69. The two tailed p-value 0.0001. Significant improvement in PASS was seen after training with VR in group A.
3. The mean value of pre SSQOL was 148.8±21.2 and after VR therapy of 6 weeks the SSQOL value post was 197.8±20.64. The mean difference was 49 .t value was 12.88 and standard error of difference was 3.79. The two tailed p-value 0.0001. Significant improvement in SSQOL was seen after training with VR in group A.
4. The mean value of pre RT (LOS component was 1.31±0.34 and after VR therapy of 6 weeks the RT value post was 0.63±0.29. The mean difference was 0.68 .t value was 7.04 and standard error of difference was 0.09. The two tailed p-value 0.0001. Significant improvement in RT was seen after training with VR in group A
5. The mean value of pre MV (LOS component) was 3.5±1.36 and after VR therapy of 6 weeks the MV value post was 7.29±1.0. The mean difference was 3.79 .t value was 9.61 and standard error of difference was 0.39. The two tailed p-value 0.0001. Significant improvement in MV was seen after training with VR in group A.
6. The mean value of pre EPE (LOS component)was 80.73±15.36 and after VR therapy of 6 weeks the EPE value post was 92.33±24.94. The mean difference was 11.6 .t value was 2.29 and standard error of difference was 5.06. The two tailed p-value 0.0380. Significant improvement in EPE was seen after training with VR in group A.
7. The mean value of pre MEPE (LOS component) was 100.86±12.80 and after VR therapy of 6 weeks the MEPE value post was 107.8±5.71. The mean difference was 6.94. And standard error of difference was 3.81. The two tailed p-value 0.094. No Significant improvement in MEPE was seen after training with VR in group A.

8. The mean value of pre DC (LOS component)was 80.06±6.97 and after VR therapy of 6 weeks the DC value post was 84.46±4.58. The mean difference was 0.4.t value was 2.52 and standard error of difference was 1.74. The two tailed p-value 0.024. No Significant improvement in DC was seen after training with VR in group A.

By applying paired t-test for group B

1. The mean value of pre TIS was 12.84±2.7 and after Conventional therapy of 6 weeks the TIS value post was 17.92±2.06.The mean difference was 5.08 .t value was 8.124, standard error of difference was 0.624. The two tailed p-value 0.0001.Significant improvement in TIS was seen after training with conventional therapy group B.
2. The mean value of pre PASS was 16.46±3.59 and after Conventional therapy of 6 weeks the PASS value post was 22±2.48. The mean difference was 5.54 .t value was 6.039, standard error of difference was 0.91. The two tailed p-value 0.0001 .Significant improvement in PASS was seen after training with conventional therapy group B.
3. The mean value of pre SSQOL was 160±25.07 and after Conventional therapy of 6 weeks the SSQOL value post was 180.69±25.44. The mean difference was 20.69 .t value was 7.379 and standard error of difference was 2.804. The two tailed p-value 0.0001. Significant improvement in SSQOL was seen after training with conventional therapy group B.
4. The mean value of pre RT (LOS component) was 1.27±0.30 and after conventional therapy of 6 weeks the RT value post was 0.97±0.12. The mean difference was 0.3 .t value was 3.738 and standard error of difference was 0.081. The two tailed p-value 0.0028. Significant improvement in RT was seen after training with conventional therapy group B.
5. The mean value of pre MV (LOS component) was 3.91±0.99 and after conventional therapy therapy of 6 weeks the MV value post was 5.97±1.160. The mean difference was 2.06 .t value was 7.980 and standard error of difference was 0.258 .The two tailed p-value 0.0001. Significant improvement in MV was seen after training with conventional therapy group B.
6. The mean value of pre EPE (LOS component) was 86.76±13.89 and after conventional therapy of 6 weeks the EPE value post was 98.69±6.98 .The mean difference was 11.93 .t value was 3.204 and standard error of difference was 3.722. The two tailed p-value 0.0076. Significant improvement in EPE was seen after training with conventional therapy group B.
7. The mean value of pre MEPE (LOS component) was104.76±4.74 and after conventional therapy of 6 weeks the MEPE value post was 106.61±5.14. The mean difference was 1.87.t value was 0.959 and standard error of difference was 1.924. The two tailed p-value 0.356. No Significant improvement in MEPE was seen after training with conventional therapy group B
8. The mean value of pre DC (LOS component) was 73.76±6.89 and after conventional therapy of 6 weeks the DC value post was 80.23±5.61. The mean difference was 6.47 .t value was 6.317 and standard error of difference was 1.023. The two tailed p-value 0.0001. Significant improvement in DC was seen after training with conventional therapy group B

By applying unpaired t-test to compare group A and Group B

1. The mean value of post TIS VR group was 9.33±2.58 and control group was 5.07±2.25. The t value was 4.612 and standard error of difference was 0.04. There was more significant improvement in TIS value of VR training group as compared to control group. As Well as also significant improvement in dynamic component score in VR group as compared to conventional group.
2. The mean value of post PASS VR group was 14.13±2.53 and control group was 5.69±3.27 .The t value was 7.684 and standard error of difference was 0.25 .There was more significant improvement in PASS value of VR training group as compared to control group. As Well as also significant improvement in MAINTAING AND CHANGING BALANCE component score in VR group as compared to conventional group.
3. The mean value of post RT VR group was 0.67±0.37 and control group was 0.35±0.33. The t value was 3.010 and standard error of difference was 0.002. There was more significant improvement in RT value of VR training group as compared to control group.
4. The mean value of post MV VR group was 3.79±1.52 and control group was 2.06±0.93. The t value was 3.550 and standard error of difference was 0.14. There was more significant improvement in MV value of VR training group as compared to control group.
5. The mean value of post EPE VR group was 17.53±12.8 and control group was 13.46±11.73The t value was 0.86 and standard error of difference was 0.069 .There was no significant difference in EPE value of VR training group and control group .

By applying Mann-Whitney test to compare between Group A and Group B

1. The mean value of post SSQOL VR group was 48.93±14.70 and control group was 20.69±10.11.The U value was 7.500 and standard error of difference was 0.99 .There was more significant improvement in SSQOL value of VR training group as compared to control
2. The mean value of post MXE VR group was 9.466±13.16 and control group was 5.23±4.71 group..The U value was 85.00 and standard error of difference was 2.09.There was no significant difference in EPE value of VR training group and control group.
3. The mean value of post DL VR group was 6.4±4.7and control group was6.4±3.68.The U value was 94.500 and standard error of difference was 0.2.There was no significant difference in MXE value of VR training group and control group.

Effect Size

In current study, Effect size of Outcome measures i.e. TIS, PASS AND SSQOL was calculated using Cohen's d method

[Cohen's *d* is defined as the difference between two means divided by a standard deviation for the data.]
Effect size of Trunk control measured by TIS was 1.759
Effect size of postural control measured by PASS was 3.784
Effect size of quality of life measured by SSQOL was 2.238

DISCUSSION

This current study compared the effect of two training programs, virtual reality using XBOX 360 Kinect and conventional physiotherapy on trunk control, postural control and quality of life of chronic stroke patients. Postural control were assessed by sitting Limit of stability and by ability of participants to maintain and change posture At the beginning of study both groups were matched for their baseline values like Age, duration of onset, TIS, PASS, LOS component, SSQOL. After intervention of 6 weeks, post test TIS, PASS, LOS component, SSQOL were again analyzed for significant difference using parametric and non parametric tests. As per the first objective, difference in trunk control in terms of Trunk impairment scale was analyzed. -It is seen that trunk control is significantly improved in both the groups from baseline pre intervention value. Group A who are trained with VR shows more significant improvement in trunk control than Group B who are trained by conventional physiotherapy methods.

When, component of trunk impairment scale like static balance, dynamic balance and coordination were compared between Group A and group B. Group A showed significantly more improvement in dynamic balance and co-ordination as compared to group B

Static balance as given in TIS scale is needed for improving ability of patients to sit on stable surface with leg on floor with and without support. In the current study, static balance at the beginning of study was better in both groups because participants were selected from chronic stroke in which static balances were not affected much. This could be the reason at the end of the study static balance has not shown any significant improvement in both the group.

Dynamic component of TIS needed for moving on paretic as well as non paretic side, moving sideways, moving forward, and lifting up paretic side as well as non paretic side.TIS states co-ordination component is essential for moving upper trunk forward on stable surface by alternating paretic as well as non paretic side, similarly moving lower trunk on stable upper trunk alternating paretic as well as non paretic side. Different games were given to participants like Tennis, Skiing, Dart, Golf and baseball; they provided enough challenge for dynamic balance and co-ordination of participants as compared to conventional physiotherapy. Difficulty level was increased as the subject performed well in previous task.

Following both games Tennis and Skiing were initially played in sitting position and as the participant improved they were made to play in standing position.

IN Tennis, ball comes from different directions, racket was given in participant's paretic hand and paretic hand was well supported by therapist so that they could move their paretic hand in order to hit the ball. This support helped them to use their trunk in better way .Stroke participants who used this game move upper extremity similar to D1 and D2 flexion-extension pattern of PNF. This encouraged participant to do necessary automatic postural adjustment. In Tennis, participants had done trunk rotation as well as trunk elongation to hit ball that came from extreme lateral direction. These movements in turn would improve upper and lower trunk dissociation as well as trunk-pelvis dissociation which are usually poor in chronic stroke patients.

In Skiing, participants were asked to sit on stable table with foot rested on ground. In skiing, participants were asked to pass RED AND BLUE Gates which were present in snow with moving their body. Participants moved their body mainly trunk sideways in order to pass gate and move body forward and backward to maintain speed and balance[30]. Trunk was well supported with belt. These Forward-backward and sideways movement of participants did unconsciously in order to pass the gate, gives weight on paretic side, move upper trunk on lower trunk, that improved their dynamic balance as well as coordination.

In Group B, where trunk control was challenged by giving different trunk exercises, balance exercises on plinth, giving reach outs in different direction, balance exercises on ball, trunk rotation exercises, balance exercises on balance board, Rhythmic rotation Trunk, PNF Pattern for upper and lower limb has also shown improvement in dynamic sitting balance and postural control as compared to its pre invention state but definitely less than VR training.

Trunk control is improved in virtual reality group probable reason could be Virtual reality training is given in simulated environment providing visual input like subject can recognize their body on screen through kinect and can move body part in order to play different games, auditory input were also provided, subjects were instructed for each game and continuous live feedback of their progress are provided through speakers, they were appreciated for their gains in every move,Somatosensory feedback is also provided to subjects by keeping hand on patients paretic arm to move it in right direction and also through trunk belt which gives feedback for appropriate movements in different directions which work on proper dissociation of trunk during game. Therefore all three components necessary to improve balance are provided in VR technique.

Studies are available which shows significant improvement in balance post visual feedback [47, 48] the structure of the brain can be enhanced using visual feedback in virtual reality to augment interconnected, distributed cortical regions. It is suggested that visual information can provide a potent signal for the reorganization of sensorimotor circuits [47]; Different cortical areas were activated, related to these artificial environment tasks. The prefrontal cortex would be activated when participants performed spatial orientation tasks [47] Subjects therefore performed well in order to win every game which improves their trunk control automatically, equally they were appreciated for their every gain that boosted their confidence and they performed well in every next session.

One more reason for improving trunk control could be muscles like trunk rotators and abdominals which mainly affected on both sides in stroke patients which are important for maintaining upright posture against gravity ,adjust weight shifts and perform selective movements of the trunk that

maintains the base of support during static and dynamic postural adjustments [30] .are trained unconsciously in a simulated environment without putting demand to fulfill activity which is seen commonly in conventional training. Evidences also show that when effect of virtual reality on static and dynamic balance seen by systemically reviewing studies in past 10 years. Dynamic balance is improved much than static in chronic stroke patients. Whereas in acute and sub acute static and dynamic both shows significant improvement[49, 50, 51,52,53,54].

When postural control are analyzed using postural assessment scale, Postural control needed for performing A.D.L'S are compared between Group Al and group B and within groups, it shows postural control is significantly improved in group A and When components of Pass are focused further, both components maintaining and changing posture has also improved significantly in group A. Probable reason for this is trunk control is improved with different games which enhance the postural control, as a trunk control is necessary to maintain postural control. Postural control required to maintain and change posture against gravity in daily living activities like turning on paretic as well as non paretic side, getting up from supine from paretic as well not paretic side, sit to stand and stand to sit, picking up different objects from ground [24]which are trained with different games as the subject crossed the previous difficulty levels.

In Dart, participant move forward, keep paretic leg ahead and therapist hold dart in participants paretic hand and throw on target by moving COG forward helps participant to stand from sitting, this also shows it enhances changing postural control which needs to improve many daily living activity in stroke patients[17]. Dart also demand trunk rotation and elongation and improve inter limb dissociation.

In Golf, participants were asked to hit ball in targeted hole ,participants were told to use involved side to play, participants held stick in paretic hand with help of non paretic hand and hence giving more weight on involved side and it also facilitates trunk rotations and upper limb and lower limb dissociation and coordination.

In Baseball, participant plays two roles one is batsman and bowler, in both roles, it required lots of transitions in movements. When participant play role of batsman he has to move sideways to hit ball, rotate from trunk to hit ball upwards and March to take runs hence needs lots of energy. When participant play role of bowler, he has to move forward to throw ball, sideways to catch ball. There are evidences which show balance training enhances postural control[55].

In this study, Table 6-10, very important component of postural control, **postural stability** (Postural stability has been defined as the ability to control the body's center of gravity (COG) within a given base of support) is measured by NeuroCom Smart Balance Master (NeuroCom International, Clackamas, OR) in sitting position. Limits of stability test provides five sets of information i.e. reaction time, movement velocity, directional control, maximum excursion and end point excursion as a person shifts his/her centre of pressure from the centre towards the visual targets displayed on the screen. In our study we compared the parameters between both the groups. Reaction time is the time in seconds between the command to move and the patient's first movement. We found average reaction time of hemiparetic patients on balance master more than the control group in sitting. In our study in all games patients are time bound to play particular turn and that influences their ability to move rapidly when command is given post VR training. Studies show that the deficit may be more prominent in acute stage and improves with rehabilitation[56]. Movement Velocity (MVL) is the average speed of COG movement in degrees per second. In dart, baseball, skiing like advance games subjects move their COG within limits in order to maintain postural stability throughout the game.

Endpoint Excursion (EPE) is the distance of the first movement toward the designated target, expressed as a percentage of maximum LOS distance. The endpoint is considered to be the point at which the initial movement toward the target ceases. Maximum Excursion (MXE) is the maximum distance achieved during the trial. Directional Control (DCL) is a comparison of the amount of movement in the intended direction (towards the target) to the amount of extraneous movement (away from the target).In this study EPE, MXE and DCL showed no significant difference in group A. Probable cause for not improving EPE and MXE is in all games targets are given for upper extremity and trunk is not challenged to move to reach the objects, hence the excursion is maximum for upper extremity.

Directional control was good in both groups pre intervention only therefore posts intervention no significant improvement is seen in this component.

Previous studies shows that if the stability limits in sitting are less, patient will not attempt more demanding tasks and will require assistance in functional activities like bathing, lower extremity dressing and picking up object from floor. Earlier evidence has also suggested that quantitative analysis of sitting limits of stability is a good way to assess sitting stability[57]. In VR training all the components of LOS are improved as compared to pre intervention. Virtual reality also has positive effect in improving dynamic postural stability.

When effect of two different treatment approaches on quality of life using SSQOL is explored, it is seen that effect VR enhances the quality of life in stroke patients when compared using SSQOL in two groups. This result was obtained because patients' motivation was increased through the virtual reality games, which gives the real environment encouraging their active participation and improving their concentration [14, 58] also the successful performance of repetitive training exercises for the damaged. In addition, errors of movement regarding task performance were shown through accurate visual and auditory sensory feedback, thereby achieving re-education of movements [59]

SSQOL assess patients quality of life describe about all the important factors like energy, family role in stroke patients, laungauge, mobility, mood, personality, self care, social roles, thinking, concentration, upper limb function, vision, productivity in work. Virtual Reality training boost patient's confidence to perform task in simulated environment, ultimate result of this was patient gain trunk and postural control and mobility and thereby enhance quality of life. Some evidences also shows that, virtual reality games were used by elderly persons, their depression decreased and there is improvement

in interpersonal relationship when assess by other quality of life scales[60, 61].

Virtual reality also shows effects of brain functions. Cramer *et al*. [62]applied finger movement training to hemiplegic stroke patients and investigated the active regions of the brain by using functional magnetic resonance imaging (fMRI). They found patients exhibited significantly more activity in the exercise neural networks near the damaged cortex area, complemented exercise area, and sensorimotor cortex in than normal controls. In addition, they report reorganization and activation of the ipsilateral motor pathway and complemented movement area around the patients' damaged region. Toyokura *et al*.[63] applied both simple and complex tasks to stroke patients and measured their sensorimotor cortex activation by using fMRI. Accordingly, the sensorimotor cortex area exhibited significantly greater activation during the complex task than the simple task. The simple task consisted of grasping and making a fist with one or both hands, while the complex task involved alternately opening and closing both hands simultaneously. Hyungjun Im *et al* [64] studied effect of virtual reality guided motor imaginary effects on brain of healthy people and stroke patients and they found that there is corticomotor excitability post virtual reality guided motor imaginary in both healthy as well as stroke patients.

In this study, Tennis and skiing improves trunk control and postural adjustment, whereas in Dart, golf, baseball improves postural control and postural stability by improving subjects COG within BOS, and thereby improving static and dynamic balance, improving ability to perform ADL'S and thereby improving quality of life. Our study results show that training using virtual reality programs using X BOX 360 improve trunk and postural control as well as quality of life in chronic stroke patients. Therefore VR using x box 360 kinect can be use as adjunct to conventional therapy in future in chronic patients rehabilitation.

CONCLUSION

- Virtual reality using X-BOX 360 kinect was found to be more effective than conventional therapy to improve trunk control in chronic stroke patients.
- Virtual reality using X-BOX 360 kinect was found to be more effective than conventional therapy to improve Postural control in terms of sitting LOS and PASS in chronic stroke patients.
- Virtual reality using X-BOX 360 kinect was found to be more effective than conventional therapy to improve quality of life in chronic stroke patients.

Hence we conclude that virtual reality training using x box 360 has shown significantly greater improvement on trunk and postural control and quality of life in chronic stroke patients.

References

1. Sin, HyeonHui MHS, OT, *et al*, Oct 2013 .Additional Virtual Reality Training Using Xbox Kinect in Stroke Survivors with Hemiplegia. *American journal of physical Medicine and rehabilitation*, -vol.92-issue 10-p 871-880.
2. Xiao Bao, Yurong Mao *et al*, 2013 Nov 5Mechanism of Kinect-based virtual reality training for motor functional recovery of upper limbs after subacute stroke Neural Regen Res.; 8(31): 2904-2913.
3. Gustavo Saposnik *et al*l, 2010 Effectiveness of Virtual Reality using wii gaming technology in stroke rehabilitation. *Stroke*; 41:1477-1484.
4. Guerrero C, Uribe *et al*, 2013, Kinect-based posture tracking for correcting positions during exercise. *Stud Health Technol Inform*; 184:158-160. [PubMed]
5. Banerjee T *et al*, 2012, Resident identification using Kinect depth image data and fuzzy clustering techniques. Conf Proc IEEE Eng Med Biol Soc 2012. 2012:5102-5105.
6. SJ, Levine P *et al*, 2005, modified constraint-induced therapy in acute stroke: a randomized controlled pilot study. *Neurorehabil Neural Repair*; 19(1):27-32.
7. Thielman G, Bonsall P, 2012, Rehabilitation of the upper extremity after stroke: a case series evaluating reotherapy and an auditory sensor feedback for trunk control. *Stroke Res Treat*. 2012 348631.
8. Kim YM, Chun MH *et al*, 2011, the effect of virtual reality training on unilateral spatial neglect in stroke patients. *Ann Rehabil Med*.; 35(3):309-315.
9. Laver KE, George S *et al*, 2011, Virtual reality for stroke rehabilitation. *Cochrane Database Syst Rev*. 9:CD008349.
10. Roberto Llorens *et al*,2014 jul-dec, Virtual Rehabilitation for Multiple Sclerosis Using a Kinect-Based System: Randomized Controlled Trial. JMIR Serious Games.
11. Ji-won Shin, MS, PT, Gui-bin Song, MS *et al*, 2015 Jul, Effects of conventional neurological treatment and a virtual reality training program on eye-hand coordination in children with cerebral palsy. *J Phys Ther Sci;* 27(7): 2151-2154.
12. Balkan Med JLevent Özgönenel *et al*, 2016, Use of Game Console for Rehabilitation of Parkinson's disease. *Balkan Med J;* 33(4): 396-400.
13. Dimbwadyo-Terrer I *et al*, 2016 Aug, Upper limb rehabilitation after spinal cord injury: a treatment based on a data glove and an immersive virtual reality environment.; *Disabil Rehabil Assist Technol.*11(6):462-7. doi: 10.3109/17483107.2015.1027293
14. Gui bin song, MS, PT *et al*, 2015 Jul, Effect of virtual reality games on stroke patients' balance, gait, depression, and interpersonal relationships.; 27(7): 2057-2060.
15. GyuChang Lee, PT, PhD, 2013 May, Effects of Training Using Video Games on the Muscle Strength, Muscle Tone, and Activities of Daily Living of Chronic Stroke Patients.*J Phys Sci.;* 25(5): 595-597. doi: 10.1589/jpts.25.595
16. Taesung In,Kyeongjin Lee *et al*,2016,Virtual Reality Reflection Therapy Improves Balance and Gait in Patients with Chronic Stroke: Randomized Controlled Trials . *Med Sci Monit;* 22: 4046-4053.
17. Yu-Hyung Park, Chi-ho Lee *et al*, 2013 Oct ,Clinical usefulness of the virtual reality-based postural control training on the gait ability in patients with stroke. *J Exercise Rehabil.;* 9(5): 489-494. doi: 10.12965/jer.130066
18. P. A. Vorkas, J. Shalhoub, M. R. Lewis *et al*. 2016, Metabolic phenotypes of carotid atherosclerotic plaques relate to stroke risk: an exploratory study. *European*

Journal of Vascular and Endovascular Surgery, vol. 52, no. 1, pp. 5-10.
19. V. L. Feigin, M. H. Forouzanfar, R *et al*. 2010,Global and regional burden of stroke during 1990-2010: findings from the Global Burden of Disease Study," *The Lancet,* vol. 383, no. 9913, pp. 245-254, 2014.
20. Ralph L.sacco, Scott E.kasner *et al*, 2013, An updated definition of stroke for the 21st century. *Stroke*, 44; 2064-2089.
21. Horstmann S, Koziol JA, Martinez-Torres F, *et al*, 2009, Sonographic monitoring of mass effect in stroke patients treated with hypothermia. Correlation with intracranial pressure and matrix metalloproteinase 2 and 9 expression. *J Neurol Sci*, 276, 75-7.
22. Bo Ryun Kim, M.D, Min Ho Chun *et al*, 2011, Aug.Effect of Virtual Reality on Cognition in Stroke Patient .Ann Rehabil Med; 35(4): 450-459.
23. Hyung Young Lee, PT *et al*, 2016, PT. Effects of virtual reality-based training and task-oriented training on balance performance in stroke patients. BMC Neurol; 16: 42.
24. Massion J1, 1994 Dec, Postural control system. *Curr Opin Neurobiol*.; 4(6):877-87.
25. Isho T1, Usuda S, 2016 Feb, Association of trunk control with mobility performance and accelerometry-based gait characteristics in hemiparetic patients with subacute stroke. Gait Posture. ; 44:89-93. doi: 10.1016/j.gaitpost.2015.11.011.
26. P Serra-Añó, M Pellicer-Chenoll *et al*,2013,.Sitting balance and limits of stability in persons with paraplegia spinal Cord ,51, 267-272; doi:10.1038/sc.2012.148;
27. Ryan P Hubble, Geraldine A Naughton *et al*,2014,Trunk muscle exercises as a means of improving postural stability in people with Parkinson's disease. a protocol for a randomized controlled trial. BMJ Open;4:e006095 doi:10.1136/bmjopen-2014-006095
28. *Davies* P, 1990- *Right in the Middle*: Selective Trunk Activity in the Treatment of Adult Hemiplegia: 1st (first) Edition. Berlin: Springer-Verlag.
29. Geert Verheyden, Alice Nieuwboer *et al*, 2007 Jul, Trunk performance after stroke: an eye catching predictor of functional outcome. *J Neurol Neurosurg Psychiatry.;* 78(7): 694-698.
30. Suruliraj Karthikbabu, Mahabala Chakrapani *et al*, 2012 Sep, Review on assessment and treatment of the trunk in stroke. *Neural Regen Res*.5; 7(25): 1974-1977.doi: 10.3969/j.issn.1673-5374.2012.25.008
31. Bruce H Dobkin. 2004 Sep, Strategies for stroke rehabilitation. *Lancet Neurol;* 3(9):528–536.
32. S Karthikbabu, Akshatha Nayak *et al*, Comparison of physio ball and plinth trunk exercises regimens on trunk control and functional balance in patients with acute stroke: a pilot randomized controlled trial. *Clinical Rehabilitation*.25 (8) 709-719 2011 DOI: 10.1177/0269215510397393.
33. Kyoung-Sim Jung, PhD, PT,Hwi-Young Cho *et al*, 2016 Mar, Trunk exercises performed on an unstable surface improve trunk muscle activation, postural control, and gait speed in patients with stroke.; 28(3): 940-944.31. doi: 10.1589/jpts.28.940
34. Joon-Ho Shin, Mi-Young Kim *et al*, 2016, Effects of virtual reality-based rehabilitation on distal upper extremity function and health-related quality of life: a single-blinded, randomized controlled trial. *J Neuroeng Rehabil;* 13: 17.
35. Palma GC, Freitas TB *et al*, 2016 Oct, Effects of virtual reality for stroke individuals based on the International Classification of Functioning and Health: a systematic review. *Stroke Rehabil*. 31:1-10.
36. L.Sheehy, A.Taillin-Hobson *et al*,2016 March, Does the addition of virtual reality training to standard program of Inpatient rehabilitation improve sitting balance ability and function after stroke? Protocol for single blind control trial. *Journal BMC Neurol*, 16:42. doi: 10.1186/s12883-016-0563-x.
37. Pangman, VC; Sloan, J *et al*. An Examination of Psychometric Properties of the Mini-Mental Status Examination and the Standardized Mini-Mental Status Examination: Implications for Clinical Practice. *Applied Nursing Research*. 13 (4): 209-213
38. Mungas D. (July 1991). In-office mental status testing: a practical guide. *Geriatrics*. 46 (7): 54-8, 63, and 66.
39. Verheyden, G., Mertin, J *et al*.The Trunk Impairment Scale: A new tool to measure motor impairment of the trunk after stroke. *Clinical Rehabilitation*, 18, 326-334.
40. Verheyden, G., Nuyens, G., Nieuwboer, A, 2006, P. V. Reliability and validity of trunk assessment for people with multiple sclerosis. *Physical Therap*, 86(1), 66–76.
41. Verheyden, G., & amp; Kersten, P, 2006, investigating the internal validity of the Trunk Impairment Scale (TIS) using Rasch analysis: The TIS 2.0. *Disability and Rehabilitation*, 1-11.
42. Marie L. Pickerill, PhD *et al*, 2011, Validity and Reliability of Limits-of-Stability Testing: A Comparison of 2 Postural Stability Evaluation Devices. *Journal of Athletic Training*:46(6):600-6
43. Benaim C1, Pérennou DA *et al*,1999 sept, Validation of a standardized assessment of postural control in stroke patients: the Postural Assessment Scale for Stroke Patients (PASS). *Stroke*. 30(9):1862-8.
44. Mojtaba Mahmoodi, Anahid Safari *et al*, 2015 APR, Stroke specific quality of life questionnaire: Test of reliability and validity of the Persian version. *Iran J Neuro*;14(2):94-100
45. Hui-fang Chen, PhD, Ching-yi Wu *et al*, 2012, Validity, Realibility and Responsiveness of a short version of the stroke specific quality of life scale in patients receiving rehabilitation. *J Rehabil Med*; 44: 629-636
46. Mariana Corduna, Gabriela Adriana Marinescu *et al*, 2014, Functional rehabilitation strategies for the improvement of balance in patients with hemiplegia after an ischemic stroke Procedia - Social and Behavioral Sciences 117 575-580.
47. Yurong Mao, Peiming Chen, Le Li *et al*,2014, Communication.Volume 9, Issue 17,Page:1628-1634
48. Seok Won Lee, PT, MS, Doo Chul Shin *et al*, 2013 May, Using virtual reality to augment perception, enhance sensorimotor adaptation, and change our minds; 25(5): 635-639.2013 Jun 29. doi: 10.1589/jpts.25.635
49. D.-S. KO, D.-I. Jung *et al*, 2014, Effect of lumbar stabilization exercises on the balance ability of patients

with stroke: a systematic review. *Journal of Physical Therapy Science,* vol. 26, no. 12, pp. 1993-1996.

50. Ling Chen, Wai Leung Ambrose Lo *et al*,(2016), Effect of Virtual Reality on Postural and Balance Control in Patients with Stroke: A Systematic Literature Review. Biomed Research International Volume 2. Article ID 7309272, 8 pages
51. J. H. Kim, S. H. Jang *et al*, 2009, Use of virtual reality to enhance balance and ambulation in chronic stroke: a double-blind, randomized controlled study. *American Journal of Physical Medicine & Rehabilitation*, vol. 88, no. 9, pp. 693-701.
52. K. H. Cho and W. H. Lee *et al*, 2013, Virtual walking training program using a real-world video recording for patients with chronic stroke: a pilot study. *American Journal of Physical Medicine & Rehabilitation*, vol. 92, no. 5, pp. 371-384.
53. K. H. Cho and W. H. Lee *et al*, 2014, Effect of treadmill training based real-world video recording on balance and gait in chronic stroke patients: a randomized controlled trial, *Gait & Posture*, vol. 39, no. 1, pp. 523-528.
54. K. H. Cho, K. J. Lee *et al*, 2012, Virtual-reality balance training with a video-game system improves dynamic balance in chronic stroke patients. *The Tohoku Journal of Experimental Medicine.* vol. 228, no. 1, pp. 69-74.
55. Alon Kalron *et al*, 2016, The effect of balance training on postural control in people with multiple sclerosis using the CAREN virtual reality system: a pilot randomized controlled trial. *Journal of Neuro Engineering* and Rehabilitation: 13DOI: 10.1186/s12984-016-0124.
56. Karajgi Asmita, Niki Shah *et al*, 2015, Analysis of Sitting Limits of Stability in Stroke Patients. *IJHSR* (12): 253-258
57. Preuss, R.A. & Popovic, M.R, 2010, Quantitative analysis of the limits of stability in sitting. *Journal of Applied Biomechanics*, 26(3), 265-272
58. Horlings CG, Carpenter MG *et al*, 2009, Influence of virtual reality on postural stability during movements of quiet stance. *Neurosci Lett*, 451: 227-231.
59. Flynn S, Palma P, and Bender A, 2007, Feasibility of using the Sony PlayStation 2 gaming platform for an individual post stroke: a case report. *J Neural Phys Ther*, 31: 180-189.
60. Lim DY, Baek IH, Yoon BG, *et al*,2012, Effect of 8-weeks' balance training on depression inventory and serotonin in individuals post-stroke. *J Korea Soc Wellness*, 7: 155-161.
61. Lee YE, Hong SJ, 2009, A study on the art therapy with game activity for the enhancement of the hand function and human relationship of the stroke elderly. *Korea J Couns,* 10: 1-16.
62. Cramer SC, Nelles G *et al*, 1997. A functional MRI study of subjects recovered from hemiparetic stroke. *Stroke*, 1997, 28: 2518-2527.
63. Toyokura M, Muro I, Komiya T, *et al*, 1999, Relation of bimanual coordination to activation in the sensorimotor cortex and supplementary motor area: analysis using functional magnetic resonance imaging. *Brain Res Bull*, 48: 211-217.
64. Hyungjun Im, MD, Jeunghun Ku *et al*, 2016 Jun, Virtual Reality-Guided Motor Imagery Increases Corticomotor Excitability in Healthy Volunteers and Stroke Patients, *Ann Rehabil Med*. 2016 Jun; 40(3): 420-431.Published online 29. doi: 10.5535/arm.2016.40.3.420.

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