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A Comparative Study Between Virtual-Based Rehabilitation and Traditional Therapy for Improving Coordination in Traumatic Brain Injury Patients with Manual Muscle Testing Above Grade 3

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ABSTRACT

Background: Traumatic Brain Injury (TBI) often disrupts coordination, impacting functional independence. Virtual-Based Rehabilitation (VBR) is emerging as a promising alternative to traditional therapies by enhancing patient motivation through immersive experiences.

Objective: To compare the efficacy of VBR and traditional physiotherapy in improving coordination among TBI patients with Manual Muscle Testing (MMT) scores above Grade 3.

Methods: A randomized controlled trial included 60 TBI patients aged 18–65 years, divided into two groups—Group A (Traditional Therapy, n=30) and Group B (VBR, n=30). Both groups received 45-minute sessions three times weekly over 6 months. Outcome measures included the Barthel Index (BI) and Berg Balance Scale (BBS). Data analysis used paired and unpaired t-tests with significance at $p < 0.05$.

Results: Both groups showed significant improvements in BI and BBS scores ($p < 0.05$). Group B showed marginally better gains, though not statistically significant compared to Group A.

Conclusion: Both rehabilitation methods significantly enhance coordination in TBI patients with MMT > Grade 3. VBR offers an engaging and potentially more motivating option for neurorehabilitation.

Keywords: *Traumatic Brain Injury, Virtual Rehabilitation, Physiotherapy, Coordination, Manual Muscle Testing*

1. INTRODUCTION

Traumatic Brain Injury (TBI) continues to pose a global health challenge, with falls, road traffic accidents, and sports injuries being primary causes. Coordination impairments from TBI arise due to disruptions in cortical and cerebellar networks. While traditional therapy has been standard for decades, it often suffers from patient fatigue and reduced compliance.

Emerging evidence suggests that Virtual-Based Rehabilitation (VBR) can improve adherence and functional outcomes by stimulating neuroplasticity through gamified, immersive experiences. This study compares VBR and traditional therapy in improving coordination among patients with sufficient muscle strength (MMT > Grade 3), targeting a critical recovery window post-TBI.

2. MATERIALS AND METHODS

Study Design: A randomized controlled trial (RCT) conducted at Pacific Medical College & Hospital, Udaipur, over a 6-month period.

Participants:

- Inclusion Criteria: Age 18–65 years
- Diagnosed with moderate TBI
- MMT > Grade 3
- Stable vitals and able to follow commands
- Exclusion Criteria:
- Severe cognitive impairments
- MMT ≤ Grade 3
- Visual/hearing impairments interfering with VR

Interventions:

- Group A (Traditional Therapy): Included strength training, neuromuscular re-education, and proprioceptive balance activities.
- Group B (VBR): Used VR headsets with interactive games focused on balance, limb coordination, and simulated ADLs.
- Frequency: 45-minute sessions, 3 times per week for 6 months.

Outcome Measures:

- Barthel Index (BI): Measures functional independence.
- Berg Balance Scale (BBS): Assesses dynamic and static balance abilities.

Statistical Analysis: SPSS version [X]; Paired t-tests were used for within-group comparison, and unpaired t-tests for between-group differences. $p < 0.05$ was considered statistically significant.

RESULTS:

A comparative experimental study conducted to evaluate the effectiveness of **Traditional Therapy (Group A)** versus **Virtual-Based Rehabilitation (Group B)** in improving **functional independence** and **balance** among individuals with **Traumatic Brain Injury (TBI)**.

Outcome measures

- **Barthel Index (BI):** to assess the level of independence in Activities of Daily Living (ADLs)
- **Berg Balance Scale (BBS):** to evaluate balance performance

Demographic Distribution:

Table 1: Sex and Age Distribution of Study Groups

Group	Male	Female	Total	Mean Age (± SEM)	SD
Group A	11	19	30	40.5 ± 2.57	14.07
Group B	16	14	30	39.8 ± 2.64	14.45

Group	Male	Female	Total	Mean Age (± SEM)	SD
Total	**27**	**33**	**60**		

Interpretation: In Group A, females (63.3%) outnumbered males (36.7%), whereas in Group B, males (53.3%) were more than females (46.7%). Both groups were age-matched with comparable mean ages and standard deviations, ensuring demographic homogeneity.

2. Pre-Intervention Comparisons

Table 2: Baseline Comparison of Barthel Index and Berg Balance Scale

Outcome Measure	Group A Mean ± SD	Group B Mean ± SD	T Statistic	P Value
Barthel Index (Pre-test)	44.3 ± 7.36	44.9 ± 7.17	0.06	<0.05
Berg Balance Scale (Pre-test)	43.1 ± 7.84	43.0 ± 7.47	0.01	

Interpretation:

There was no statistically significant difference between Group A and Group B in baseline scores of both Barthel Index and Berg Balance Scale ($P > 0.05$), confirming that groups were comparable prior to the intervention.

3. Within-Group Improvements

Table 3: Pre- and Post-Test Comparisons Within Groups

Measure	Group	Pre-test Mean ± SD	Post-test Mean ± SD	Mean Difference	T Statistic	P Value
Barthel Index	A	44.3 ± 7.36	73.5 ± 6.35	29.2	38.25	<0.001
Barthel Index	B	44.9 ± 7.17	73.7 ± 6.15	28.8	74.10	<0.001
BBS	A	43.1 ± 7.84	69.4 ± 7.14	26.3	25.28	<0.001
BBS	B	43.0 ± 7.47	69.9 ± 6.88	26.9	48.12	<0.001

Interpretation:
Both groups showed statistically significant improvements ($P < 0.001$) in their post-test scores for both Barthel Index and Berg Balance Scale, indicating that **both traditional and virtual-based rehabilitation methods were effective** in enhancing independence and balance.

4. Between-Group Post-Test Comparisons

Table 4: Post-Test Comparison Between Group A and Group B

Outcome Measure	Group A Mean ± SD	Group B Mean ± SD	Mean Difference	T Statistic	P Value
Barthel Index	73.5 ± 6.35	73.7 ± 6.15	0.2	0.25	<0.05
Berg Balance Scale	69.4 ± 7.14	69.9 ± 6.88	0.5	0.20	

Interpretation:

No significant difference was observed in post-intervention scores between Group A and Group B for either Barthel Index or Berg Balance Scale ($P > 0.05$), suggesting that both intervention strategies were **equally effective.**

3. DISCUSSION

Both traditional and virtual-based therapies effectively enhanced coordination in TBI patients. While the improvement margins were similar, the immersive nature of VBR likely contributed to increased engagement and possibly better adherence, especially in younger demographics.

Key Insight: VBR may foster more sustainable rehabilitation outcomes by combining motor, cognitive, and visual stimuli that activate multisensory networks in the brain.

Limitations:

- Small sample size
- Short duration
- Lack of follow-up data
- Future Directions:
- Multi-center trials
- Longitudinal studies on retention of motor gains
- Inclusion of neuroimaging or EEG to observe neural adaptations

4. CONCLUSION

Virtual-Based Rehabilitation and traditional physiotherapy are both effective in improving coordination among TBI patients with MMT > Grade 3. While outcomes are comparable, VBR introduces a novel, engaging dimension to rehabilitation and holds promise for broader adoption in neurorehabilitation programs.

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