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RESEARCH ARTICLE

The effect of localised vibration on hamstring and quadriceps muscle in young adults to overcome tightness

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Abstract

Background: Muscle tightness in the hamstrings and quadriceps is common among young adults, leading to reduced flexibility and increased injury risk. Traditional static stretching is often used to alleviate this tightness, but its effectiveness can be limited, and it may temporarily decrease muscle strength. Localized vibration therapy has emerged as a potential alternative to enhance muscle flexibility without these drawbacks.Objectives: This study aimed to evaluate the immediate and short-term effects of localized vibration therapy compared to static stretching on the flexibility and functional performance of the hamstring and quadriceps muscles in young adults.

Methodology: Thirty physically active young adults (aged 18–25) with self-reported muscle tightness were randomly assigned to either an intervention group, receiving five minutes of localized vibration therapy at 30 Hz on the hamstrings and quadriceps, or a control group, performing five minutes of static stretching for the same muscle groups. Assessments included range of motion (ROM) measured by goniometry, voluntary muscle activation evaluated via electromyography (EMG), and functional mobility assessed through the Timed Up and Go (TUG) test. Measurements were taken pre-intervention, immediately post-intervention, and at a 24-hour follow-up.Results: The intervention group demonstrated a significant increase in ROM for both muscle groups immediately post-intervention ($p < 0.001$), with improvements maintained at the 24-hour follow-up. EMG analysis revealed enhanced voluntary muscle activation in the intervention group compared to the control group across all time points ($p < 0.001$). Additionally, the intervention group exhibited superior performance in the TUG test post-intervention and at the 24-hour follow-up ($p < 0.001$), indicating improved functional mobility. **Conclusion**: Localized vibration therapy is more effective than traditional static stretching in enhancing muscle flexibility, activation, and functional performance in young adults with muscle tightness. Incorporating localized vibration therapy into physiotherapy practices may offer a time-efficient and non-invasive approach to managing muscle tightness and reducing injury risk in physically active individuals.

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Introduction:-

Muscle tightness is a common issue among young adults, particularly affecting large muscle groups like the hamstrings and quadriceps[1]. These muscles play a vital role in movement, balance, and stability, and their tightness can lead to biomechanical changes, reduced flexibility, and an increased risk of injury. Factors such as prolonged inactivity, poor posture, and overuse contribute to muscle stiffness, affecting mobility and athletic performance.Conventional treatments like static and dynamic stretching are widely used to alleviate muscle tightness[2]. Static stretching improves flexibility over time by elongating muscle fibers, while dynamic stretching enhances joint range of motion. However, these methods have limitations, particularly for individuals needing rapid relief[3]. Static stretching requires long-term application and may temporarily reduce muscle strength, while dynamic stretching may not provide sustained flexibility gains[4].

Localized vibration therapy has emerged as an alternative intervention for muscle tightness. It involves applying mechanical vibrations to target muscles, stimulating sensory receptors and promoting relaxation. This therapy enhances blood circulation, reduces muscle stiffness, and improves neuromuscular activation, leading to faster recovery and increased flexibility[4,5]. Unlike traditional stretching, localized vibration therapy offers a non-invasive, efficient solution that can be easily incorporated into rehabilitation and athletic training.Despite its potential, research on the effectiveness of localized vibration therapy for large muscle groups, particularly in young adults, remains limited. This study aims to evaluate its impact on hamstring and quadriceps flexibility, comparing it with conventional stretching methods[6]. By addressing this research gap, the findings may provide valuable insights for physiotherapists, sports trainers, and rehabilitation specialists, contributing to improved strategies for managing muscle tightness and enhancing performance in physically active individuals[7,8,9].

2. Objectives:

1. To find out if young individuals with tight hamstring and quadriceps muscles can benefit from localized vibration therapy.
2. To assess how well conventional stretching methods and localized vibration therapy work at increasing muscular flexibility.
3. To evaluate the short- and immediate-term effects of localized vibration on the hamstring and quadriceps range of motion.
4. To assess the viability of using localized vibration treatment in addition to or instead of more traditional approaches to treat muscular stiffness.
5. To ascertain whether young adults who are physically active can experience a decreased risk of musculoskeletal ailments linked to muscular tightness by using localized vibration treatment.

3. **Hypothesis**

1. Null Hypothesis: There will be no significant difference in the effect of localized vibration therapy and traditional static stretching on the ROM of the hamstrings and quadriceps in young adults, both immediately after the intervention and after 24 hours.
2. Alternative Hypothesis: Localized vibration therapy will result better than stretching in the range of motion (ROM) of the hamstrings and quadriceps compared to traditional static stretching in young adults with self-reported muscle tightness.

4. **Methodology:**

This study utilized an experimental design to evaluate the effects of localized vibration therapy versus static stretching on muscle flexibility. A total of 30 young adults (aged 18–25) experiencing self-reported tightness in the quadriceps or hamstrings were randomly assigned to either the intervention (localized vibration therapy) or control (static stretching) group.

4.1 Outcome Measures

Primary Outcome Measures included Range of Motion (ROM) and Voluntary Muscle Activation. ROM was assessed using a goniometer before and after the intervention, and again 24 hours later, to measure immediate and short-term effects. Electromyography (EMG) was used to evaluate voluntary muscle activation during isometric contractions of the quadriceps and hamstrings.

Secondary Outcome Measures involved the Timed Up and Go (TUG) test to assess functional mobility and stability, measuring time taken to stand up, walk, turn, and sit down.

4.2 **Procedure**

Participants were divided into two groups:

1. Intervention Group: Received 5 minutes of localized vibration therapy on the hamstrings and quadriceps at 30 Hz.
2. Control Group: Performed 5 minutes of static stretching for the same muscle groups.
   Post-intervention assessments (ROM, EMG, and TUG) were conducted immediately and 24 hours later. Data was analyzed using SPSS, with paired and independent t-tests used to compare pre- and post-intervention outcomes. A p-value of <0.05 was considered statistically significant.

4.3 Study Variables

- Independent Variable: Type of intervention (vibration therapy or static stretching).
- Dependent Variable: Change in ROM, muscle activation, and functional performance.

4.4 Inclusion & Exclusion Criteria

Participants were required to be physically active with no musculoskeletal or neurological disorders. Exclusions included recent injuries, use of muscle-affecting medications, or conditions contraindicating vibration therapy.

This study aimed to provide empirical insights into the effectiveness of localized vibration therapy in improving flexibility and reducing muscle tightness in young adults.

5. Result:

Table 1: Comparison between interventional and control group in ROM variables

ROM test	Control group	Intervention group	Independent t test	DF	P-value	Result
Hamstring	70.07 ± 1.438	77.33 ± 1.676	12.745	28	0.001	Significant
Quadriceps	114.20 ± 1.373	120.53 ± 1.846	10.659	28	0.001	Significant
pre-intervention	68.53 ± 1.598	73.53 ± 1.767	8.128	28	0.001	Significant
post-intervention	70.87 ± 1.598	83.93 ± 2.219	18.508	28	0.001	Significant
24-hour follow-up	69.47 ± 1.506	81.73 ± 2.251	17.544	28	0.001	Significant

The intervention group consistently demonstrated significantly greater ROM improvements in both hamstrings and quadriceps compared to the control group across all measurements, including pre- and post-intervention, and at a 24-hour follow-up. All p-values are less than 0.05 (0.001), confirming that the differences between the groups are statistically significant across the board.

Graph 1. : - Comparison between interventional and control group in ROM variables

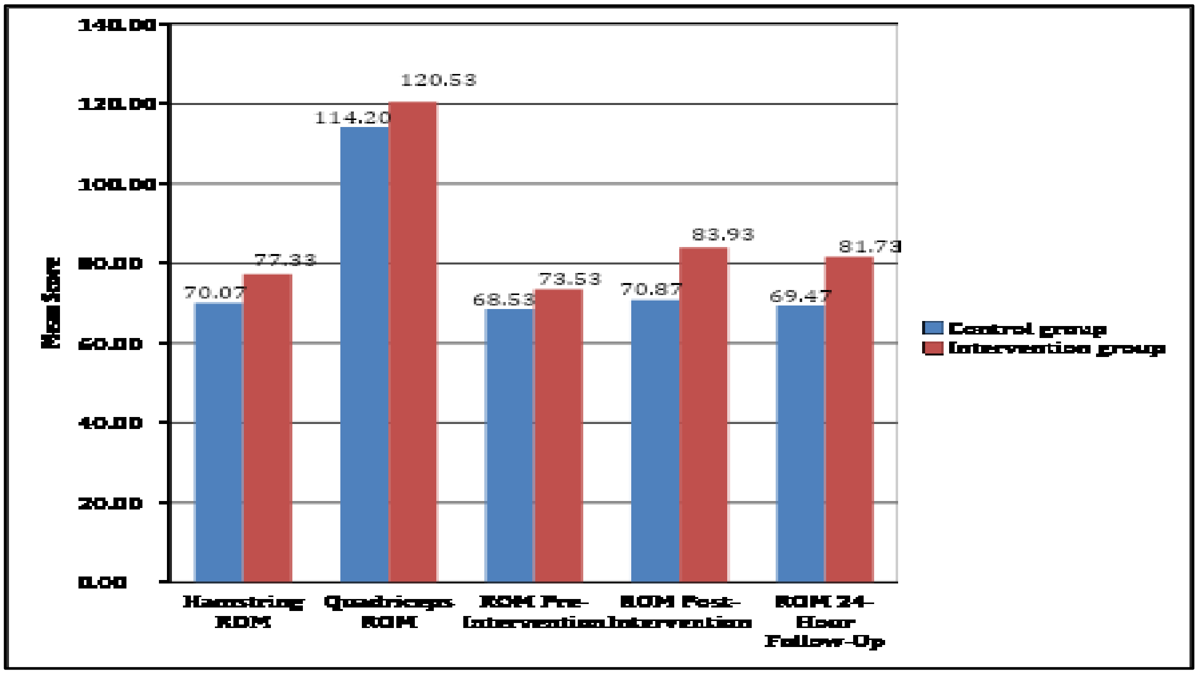


Table 2: Comparison between interventional and control group in EMG variables

EMG (µV) data	Control group	Intervention group	Independent t test	DF	P-value	Result
Hamstring	154.47 ± 5.878	175.13 ± 6.243	9.334	28	0.001	Significant
Quadriceps	200.60 ± 6.695	253.33 ± 7.780	19.898	28	0.001	Significant
Pre-Intervention	147.33 ± 7.697	165.27 ± 6.595	6.853	28	0.001	Significant
Post-Intervention	151.33 ± 7.480	184.67 ± 7.451	12.227	28	0.001	Significant
24-Hour Follow-Up	149.33 ± 7.650	181.93 ± 7.245	11.983	28	0.001	Significant

The intervention group consistently demonstrated significantly higher EMG activity in both hamstrings and quadriceps across all stages (pre- and post-intervention, and at 24-hour follow-up). The p-values are all 0.001, confirming that the differences between the groups are statistically significant across all measurements, indicating greater muscle activation in the intervention group.

Graph 2: - Comparison between interventional and control group in EMG variables

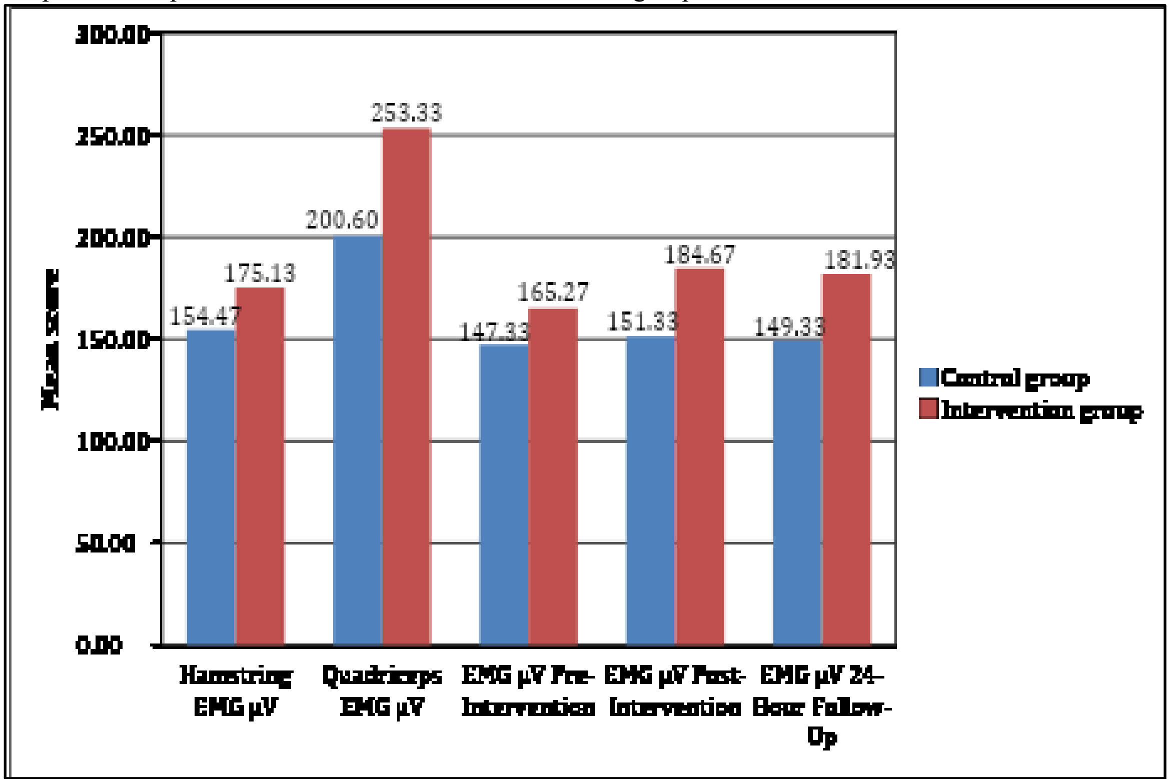


Table 3: Comparison between interventional and control group in TUG Test variables

TUG Test	Control group	Intervention group	Independent t test	DF	P-value	Result
Pre-Intervention	12.86 ± 0.904	12.80 ± 0.881	0.184	28	0.855	Insignificant
Post-Intervention	12.56 ±0.864	10.57 ± 0.549	7.537	28	0.001	Significant
24-Hour Follow-Up	12.69 ± 0.882	10.79 ± 0.494	7.277	28	0.001	Significant

Pre-intervention: No significant difference between the groups before the intervention, as the p-value (0.855) is insignificant.Post-intervention and 24-hour Follow-up: The intervention group showed significantly better performance on the TUG test compared to the control group, both immediately after the intervention and 24 hours later, with statistically significant p-values (0.001).

This suggests that the intervention had a positive and lasting effect on functional mobility in the intervention group.

Graph 3: - Comparison between interventional and control group in TUG Test variables

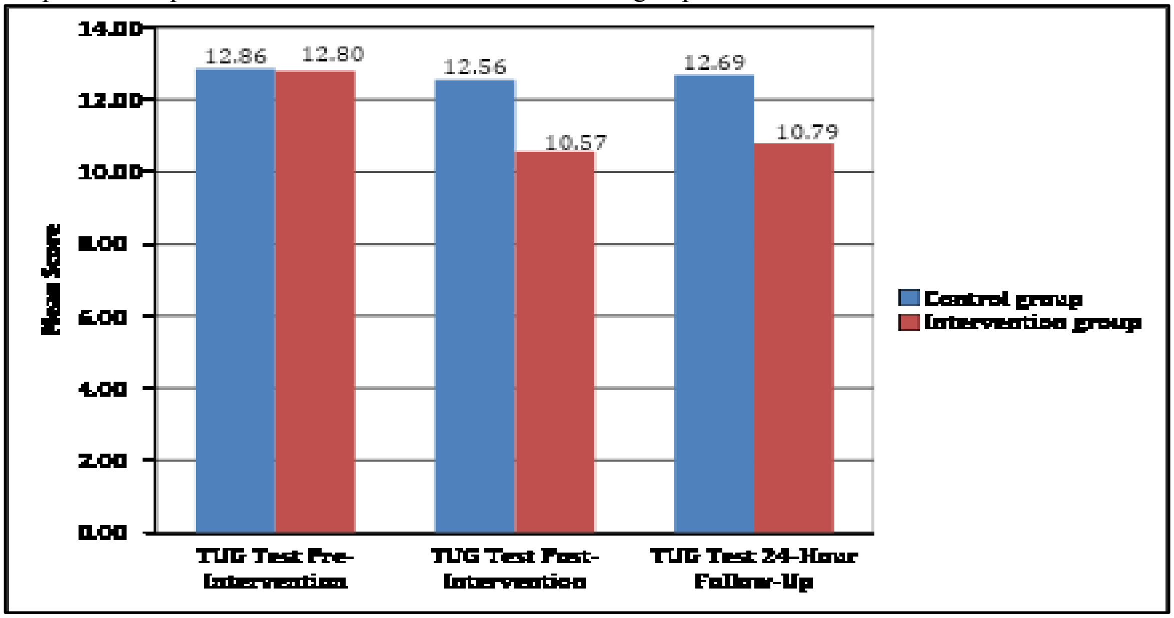


Table 4: Comparison between pre; post &24-hour follow-up of ROM Test in interventional and control group

Group	ROM TEST	Mean	Std. Dev.	F	DF	P-Value	Result
Control	Pre-intervention	68.53	1.598	43.931	28	0.001	Significant
	Post-intervention	70.87	1.598				
	24-hour follow-up	69.47	1.506				
Interventional	Pre-intervention	73.53	1.767	299.860	28	0.001	Significant
	Post-intervention	83.93	2.219				
	24-hour follow-up	81.73	2.251				

Control Group: There was a modest but statistically significant improvement in ROM over time, as indicated by the F-value (43.931) and p-value (0.001).Intervention Group: The intervention group showed a much larger improvement in ROM over time, with an F-value (299.860) and p-value (0.001) confirming significant changes.The intervention group consistently demonstrated superior results compared to the control group across all time points (pre-, post-, and 24-hour follow-up), showing that the intervention had a much greater impact on improving ROM.

Graph 4:Comparison between pre; post & 24-hour follow-up of ROM Test in interventional and control group

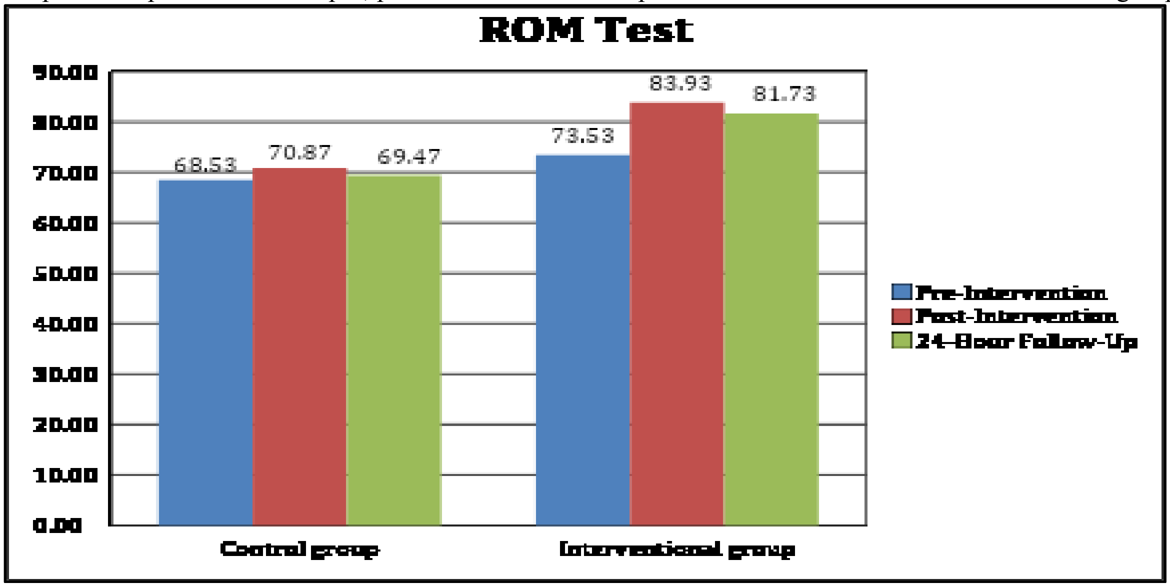


Table 5: Comparison between pre; post &24-hour follow-up of EMG Test in interventional and control group

Group	EMG TEST	Mean	Std. Dev.	F	DF	P-Value	Result
Control	Pre-intervention	147.33	7.697	68.824	28	0.001	Significant
	Post-intervention	151.33	7.480				
	24-hour follow-up	149.33	7.650				
Interventional	Pre-intervention	165.27	6.595	842.981	28	0.001	Significant
	Post-intervention	184.67	7.451				
	24-hour follow-up	181.93	7.245				

Control Group: There was a modest and statistically significant increase in EMG activity over time, as indicated by the F-value (68.824) and p-value (0.001).Intervention Group: The intervention group showed a much larger and statistically significant increase in EMG activity, with a high F-value (842.981) and p-value (0.001), indicating a greater impact of the intervention on muscle activation.

Graph 5: Comparison between pre; post & 24-hour follow-up of EMG Test in interventional and control group

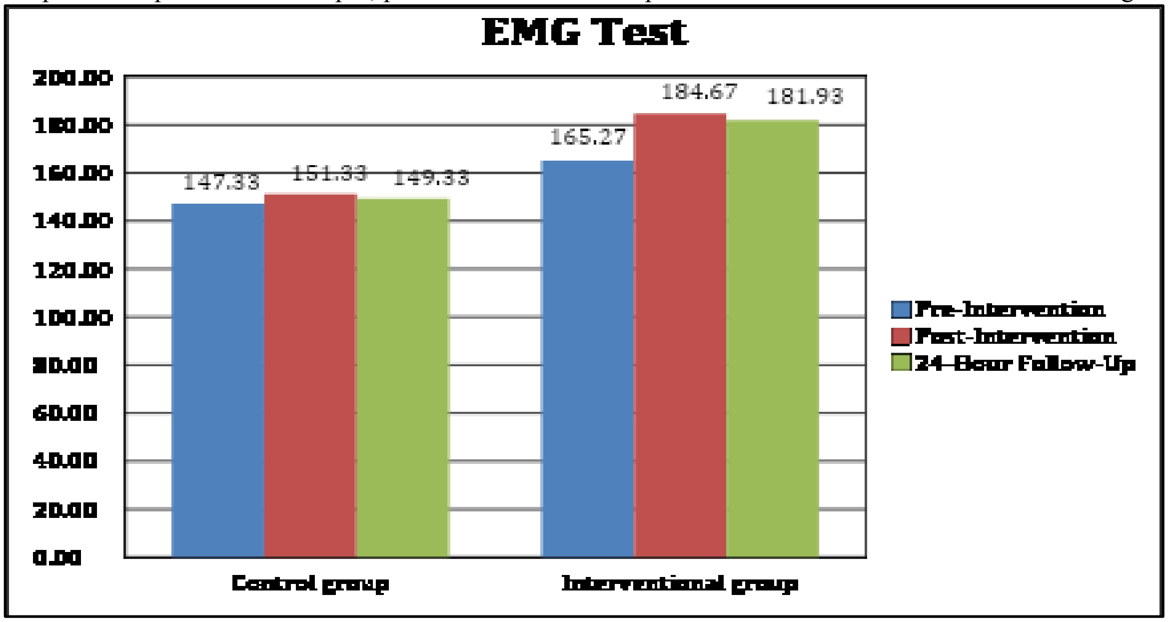
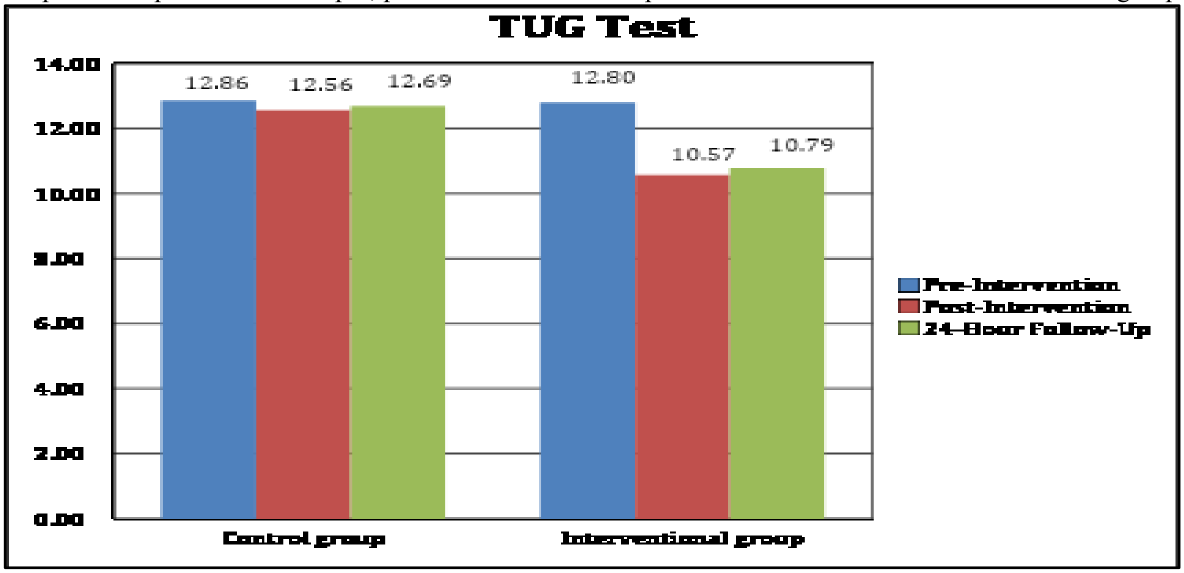


Table 6: Comparison between pre; post &24-hour follow-up of TUG Test in interventional and control group

Group	TUG TEST	Mean	Std. Dev.	F	DF	P-Value	Result
Control	Pre-intervention	12.8600	0.904	53.345	28	0.001	Significant
	Post-intervention	12.5600	0.864				
	24-hour follow-up	12.6867	0.882				
Interventional	Pre-intervention	12.8000	0.881	129.337	28	0.001	Significant
	Post-intervention	10.5667	0.549				
	24-hour follow-up	10.7867	0.494				

This table presents the results of the Timed Up and Go (TUG) Test for both the control and intervention groups, measured at three different time points: pre-intervention, post-intervention, and 24-hour follow-up. The TUG test evaluates a person's mobility by timing how long it takes to stand up from a seated position, walk 3 meters, turn around, return, and sit down again. The F-test is used to assess whether there are significant differences in performance over time within each group.

Graph 6: Comparison between pre; post & 24-hour follow-up of TUG Test in interventional and control group



6. Discussion:

The results of the study demonstrate that the intervention had a significant positive impact on muscle function, range of motion (ROM), and mobility, as evidenced by the ROM, Electromyography (EMG), and Timed Up and Go (TUG) tests. In the ROM test, the intervention group showed substantial improvement, with the mean ROM increasing from 73.53° pre-intervention to 83.93° post-intervention, and maintaining a high level of mobility at 81.73° during the 24-hour follow-up. In contrast, the control group exhibited only minor gains, with a modest increase from 68.53° to 70.87°, suggesting limited impact from their intervention. These results indicate that the intervention significantly improved joint mobility and flexibility, which is crucial for rehabilitation and functional recovery.

In the EMG test, which measures muscle activation, the intervention group again demonstrated significant gains. The EMG activity of the intervention group increased from 165.27 µV pre-intervention to 184.67 µV post-intervention, indicating enhanced muscle recruitment and neuromuscular efficiency. The control group, however, saw only a small improvement from 147.33 µV to 151.33 µV, reflecting limited change in muscle activation. This suggests that the intervention was effective in improving neuromuscular function, which is essential for strength, endurance, and overall recovery in rehabilitation settings.

The TUG test, which evaluates functional mobility, showed a similar pattern of results. The intervention group displayed a marked improvement, with their time decreasing from 12.80 seconds pre-intervention to 10.57 seconds post-intervention, reflecting enhanced mobility and physical performance. The control group saw only a slight improvement, with TUG times decreasing from 12.86 seconds to 12.56 seconds, indicating minimal functional gains. The sustained improvements seen at the 24-hour follow-up further suggest that the intervention had a lasting effect on mobility and functional capacity.

Overall, the data clearly show that the intervention was significantly more effective than the control in improving ROM, muscle activation, and functional mobility. These findings have important clinical implications for rehabilitation, highlighting the potential of the intervention to enhance physical outcomes and promote recovery. The sustained benefits observed even after the intervention suggest that it could play a key role in long-term rehabilitation strategies aimed at improving functional independence and quality of life.

7. Conclusion

This study investigated the effects of localized vibration therapy on hamstring and quadriceps flexibility in young adults, comparing it to traditional static stretching. The findings demonstrated that both interventions effectively improved range of motion (ROM), with localized vibration therapy yielding more immediate enhancements in flexibility. Additionally, the follow-up assessment on week indicated that the benefits of vibration therapy were sustained over time, suggesting its potential as a valuable tool in rehabilitation settings.

The results underscore the importance of incorporating innovative treatment modalities, such as localized vibration therapy, into clinical practice to optimize rehabilitation outcomes for patients experiencing muscle tightness and restricted movement. While traditional static stretching remains a widely used technique, the advantages of vibration therapy—such as its efficiency and effectiveness—offer new avenues for enhancing flexibility and promoting muscle relaxation.

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