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Immediate Effects of Myofascial Release and Mechanical Vibration Therapy on Muscle Fatigue Recovery: A Randomized Controlled Trial

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Abstract

Background: Muscle fatigue, a temporary decline in the ability of muscles to generate force, can hinder athletic performance and recovery. Conventional strategies like rest and stretching often offer limited benefits. Emerging interventions, such as Mechanical Vibration Therapy (MVT) and Myofascial Release (MFR), show promise, but direct comparative evidence is limited. This study aimed to evaluate the immediate effects of MVT, MFR, and passive rest on fatigue recovery and performance.

Methods: A randomized controlled trial included 90 healthy young adults (mean age 20.7±1.6 years), randomly assigned to MVT (n=30), MFR (n=30), or passive rest (n=30). Fatigue was induced using repeated jump-sprint exercises to exhaustion. Each intervention lasted 20 minutes post-fatigue. Perceived fatigue was assessed using the Visual Analog Scale for Fatigue (VAS-F), and performance was measured with Vertical Jump Power (VJP) before fatigue, after fatigue, and post-intervention. Repeated-measures ANOVA with Tukey's post hoc tests was used for analysis ($p<0.05$).

Results: Significant group × time interactions were observed for VAS-F and VJP ($p<0.01$). MVT produced the largest reduction in fatigue (29.5%) and significantly improved VJP ($p<0.01$). MFR reduced perceived fatigue ($p<0.01$), but did not significantly enhance VJP. Passive rest showed minimal recovery, with slight fatigue reduction and performance decline.

Conclusion: MVT was more effective than MFR and passive rest for rapid recovery, reducing fatigue and restoring performance. MFR provided moderate subjective relief, while passive rest was least effective. MVT may be valuable in athletic and rehabilitation settings, warranting further study of long-term effects.

Keywords: Analog scale, Analysis of variance, Humans, Muscle fatigue, Myofascial release therapy, Muscles, Vibration, Visual athletic performance, Young adult

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Introduction

Muscle fatigue is marked by a temporary drop in a muscle's ability to generate force or power. It often occurs after intense activity and significantly affects rehabilitation and athletic performance (1,2). This fatigue arises from complex interactions between central and peripheral factors, resulting in lower neuromuscular efficiency, reduced exercise tolerance, and slower recovery (1,3). Fatigue not only affects immediate performance, but also raises the risk of injury and lengthens recovery time, which is particularly important for athletes and people in rehabilitation (2,3).

Traditional recovery methods like passive rest, stretching, massage, and electrotherapy are commonly used. However, these approaches often offer only limited or delayed relief from fatigue-related issues (4,5). For instance, while passive rest allows metabolic recovery, it does little to boost neuromuscular readiness right away. Stretching and massage might ease soreness, but have inconsistent results on immediate performance recovery (4,5). This situation has sparked interest in alternative physiotherapy methods that could speed up recovery and improve outcomes.

Myofascial Release (MFR) is one technique that is becoming more popular in clinics and among athletes. MFR uses sustained pressure and stretching of the fascial system to decrease adhesions, restore tissue movement, and improve blood flow (6,7). Research shows it can reduce fascial tightness, increase range of motion, and alleviate pain in various musculoskeletal issues (8-10). By improving neuromuscular movement and circulation, MFR is thought to aid recovery after activities that cause fatigue (6-9). Systematic reviews and randomized controlled trials have reported positive results from MFR in both clinical and athletic settings, although its effects on immediate fatigue and performance still need to be more clearly defined (7,9,10).

Mechanical Vibration Therapy (MVT) is another new method for recovering from fatigue. MVT uses oscillatory mechanical stimuli on muscles, which enhances proprioceptive feedback, activates muscle spindles, and boosts neuromuscular efficiency (11). Evidence indicates that vibration therapy may improve blood circulation, speed up the removal of metabolic waste, and encourage neuromuscular activation, all of which contribute to quicker recovery from fatigue (11-13). Several studies have shown improvements in flexibility, performance, and a lower sense of exertion after vibration therapy in both athletes and rehabilitative populations (12,13).

While both MFR and MVT have shown positive effects in reducing fatigue and enhancing functional outcomes, there are few direct comparison studies of these techniques. With the growing need for effective recovery methods in athletic and rehabilitative settings, it is crucial to determine which technique offers better results for acute fatigue recovery. This study aims to compare the immediate effects of MFR, MVT, and passive rest on recovery from fatigue and performance, with the hypothesis that MVT will provide the most significant benefits.

Materials and Methods

Study design and setting

This study was a randomized controlled trial conducted at GD Goenka University in Haryana, India, from February to March 2025. Ethical approval was received from the Institutional Ethics Committee (IEC No. F.1/IEC/WWE/(06)/04/2024/No.13). The trial was registered in the Clinical Trial Registry of India (CTRI/2025/01/079026). All participants gave written informed consent before enrollment, and the study followed the Declaration of Helsinki.

Participants

90 healthy adults aged 18 to 30 years were recruited from the university community. Participants were either sedentary or moderately active, based on the International Physical Activity Questionnaire. Anyone with a history of musculoskeletal injury in the past six months, neurological or cardiovascular disorders, or prior exposure to MFR or MVT techniques was excluded. Eligible participants were randomly assigned to three equal groups (30 per group):

Group 1: Mechanical Vibration Therapy (MVT)
Group 2: Myofascial Release (MFR)
Group 3: Passive Rest (Control)

Randomization and blinding

An independent researcher, who was not involved in

data collection, generated random allocations using computer software. Allocation concealment was ensured through sealed opaque envelopes. Because of the nature of the interventions, it was not possible to blind participants or therapists. However, the outcome assessors and data analysts were kept unaware of group assignments.

Fatigue induction protocol

Fatigue was induced using a standardized protocol that included repeated sets of five vertical jumps followed by a 30-*meter* sprint. This was done until participants reached volitional exhaustion. Participants received encouragement to give maximum effort throughout. Fatigue was confirmed when participants could no longer perform the tasks with proper form despite motivation.

Interventions

All interventions lasted for 20 *min* and took place right after the fatigue protocol.

Mechanical Vibration Therapy (MVT): A handheld fascial gun device was used (TY-603 model) that delivered oscillations at a 9 *mm* amplitude to the gluteal muscles, hamstrings, quadriceps, and calves for 90 *s* on each muscle.

Myofascial Release (MFR): A trained physiotherapist applied manual therapy techniques including deep stroking, sustained pressure, and both active and passive fascial stretching to the same muscle groups.

Passive Rest (Control): Participants remained seated quietly in a resting position without engaging in any physical activity or intervention.

Outcome measures

Two primary outcomes were assessed: Visual Analog Scale for Fatigue (VAS-F): This was a 100 *mm* horizontal line where participants marked their perceived fatigue, with 0 meaning "no fatigue" and 100 meaning "extreme fatigue".

Vertical Jump Power (VJP): This was calculated from vertical jump height and body weight using a validated formula, which has shown reliability and sensitivity for assessing lower limb power.

Measurements were taken at three time points: pre-fatigue, post-fatigue, and post-intervention.

Statistical analysis

Data was analyzed using SPSS version 25.0. Descriptive statistics (mean ± standard deviation) was calculated for demographic and outcome variables. Intra-group comparisons were performed across time points using repeated-measures ANOVA, and inter-group differences were examined with two-way ANOVA followed by a post hoc Tukey's HSD test. A level of $p<0.05$ was considered to be statistically meaningful.

Results

Participant characteristics

A total of 90 participants (mean age: 20.7±1.6 years; 46 males and 44 females) were enrolled and completed the trial. No dropouts or adverse events were reported during the study period. Baseline demographic and anthropometric variables (age, gender distribution, height, weight, and body mass index) were similar across the three groups, with no statistically significant differences ($p>0.05$).

Table 1 presents the baseline characteristics of participants in each group.

Fatigue induction

The fatigue protocol (vertical jumps followed by 30-*m* sprints until exhaustion) effectively caused a measurable decline in performance across all groups. This was shown by increased VAS-Fatigue (VAS-F) scores and reduced Vertical Jump Power (VJP) values

Table 1. Baseline demographic characteristics of study population (n=90)

Variable	MVT group (n=30)	MFR group (n=30)	Passive rest (n=30)	p-value
Age (years, Mean±SD)	20.3±1.2	20.9±2.0	20.8±1.7	>0.05
Gender (Male/Female)	14/16	13/17	18/12	>0.05

No significant differences were observed between groups at baseline.

post-fatigue compared to pre-fatigue ($p<0.01$ for all).

Intra-group comparisons

Mechanical Vibration Therapy (MVT group): VAS-F scores significantly decreased from 99.87±12.1 post-fatigue to 70.32±11.4 post-intervention ($p<0.01$).

VJP significantly improved from 7723.65±510.4 W post-fatigue to 8301.21±478.6 W post-intervention ($p<0.01$).

Myofascial Release (MFR group): VAS-F scores reduced from 108.51±10.6 post-fatigue to 69.20±13.2 post-intervention ($p<0.01$).

VJP showed a non-significant increase from 7892.74±525.3 W post-fatigue to 8069.17±498.7 W post-intervention ($p>0.05$).

Passive Rest (Control group): VAS-F scores decreased slightly from 111.20±9.8 post-fatigue to 108.15±10.4 post-intervention ($p>0.05$).

VJP declined further from 8334.9±550.2 W post-fatigue to 8164.3±564.8 W post-intervention ($p>0.05$).

Table 2 summarizes intra-group changes in fatigue and performance measures.

Inter-group Comparisons

Two-way repeated-measures ANOVA showed significant group×time interaction effects for both VAS-F ($F=12.87$, $p<0.01$) and VJP ($F=9.46$, $p<0.01$).

VAS-Fatigue: Post hoc analysis (Tukey's HSD) showed that both MVT and MFR produced significantly greater reductions in fatigue scores compared to passive rest ($p<0.01$). Moreover, MVT led to a greater reduction in VAS-F than MFR ($p<0.05$).

Vertical Jump Power: MVT significantly improved VJP compared to both MFR ($p<0.05$) and passive rest ($p<0.01$). MFR did not show significant differences from passive rest in terms of VJP restoration ($p>0.05$).

Figure 1 illustrates the comparative changes in VAS-F across groups, while figure 2 depicts VJP trends pre-fatigue, post-fatigue, and post-intervention.

Discussion

This randomized controlled trial looked at the immediate effects of MVT, MFR, and passive rest on muscle fatigue recovery and performance in healthy young adults. The findings show that MVT was the most effective method. It significantly reduced perceived fatigue and improved VJP. In contrast, MFR lowered subjective fatigue, but did not result in measurable performance gains. Meanwhile, passive rest offered only minor improvements in both fatigue feelings and functional performance. These results suggest that MVT provides better benefits for quick recovery, especially when there is a need for immediate restoration of neuromuscular performance. This highlights its potential use in sports and rehabilitation. Overall, these findings indicate that MVT is more effective than MFR and passive recovery in handling acute fatigue, especially for quickly restoring neuromuscular performance.

Fatigue recovery

Mechanisms and implications: Muscle fatigue comes from both peripheral factors, like metabolite buildup, ionic imbalance, and reduced muscle

Table 2. Comparison of fatigue (VAS-F) and performance (VJP) across groups

Outcome measure/time point	MVT group (n=30) (Mean±SD)	MFR group (n=30) (Mean±SD)	Passive rest group (n=30) (Mean±SD)
VAS-F Pre-fatigue	53.28±13.0	54.54±13.0	52.34±8.0
VAS-F Post-fatigue	99.87±29.9	108.51±22.2	111.20±19.8
VAS-F Post-intervention	70.32±20.6 ↓*	69.20±14.0 ↓*	108.15±28.6 (ns)
VJP Pre-fatigue	8183.97±630.0	8147.89±735.3	8917.2±565.4
VJP Post-fatigue	7723.65±620.8	7752.57±635.4	8334.9±421.8
VJP Post-intervention	8301.21±644.0 ↑*	8069.17±729.2 (ns)	8164.3±434.6 ↓

↓ Significant reduction ($p < 0.01$); ↑ Significant improvement ($p < 0.01$); (ns) Non-significant change.

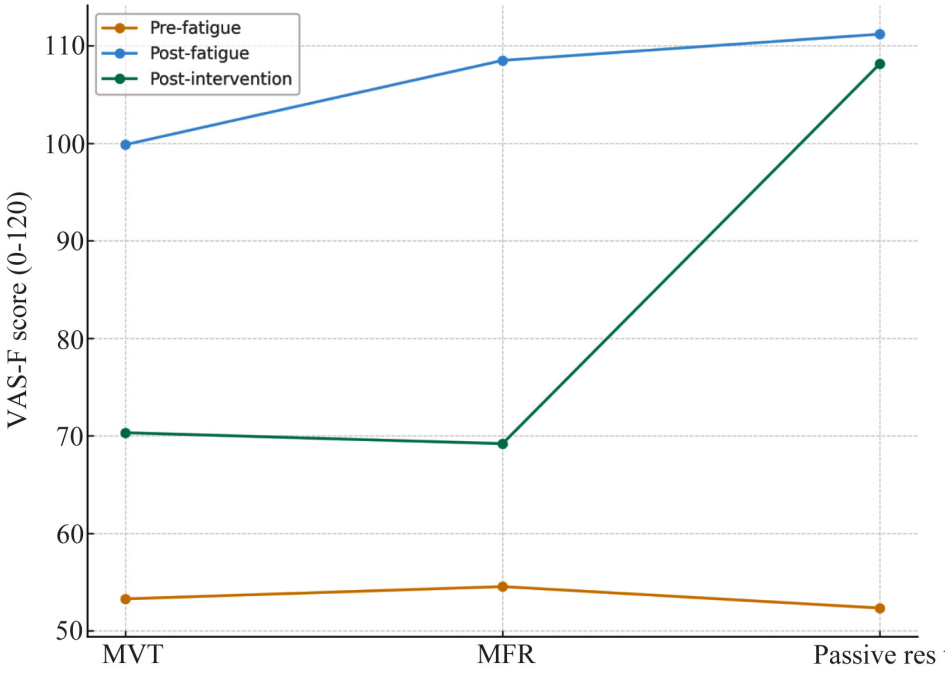


Figure 1. Changes in perceived fatigue (VAS-F) across groups.

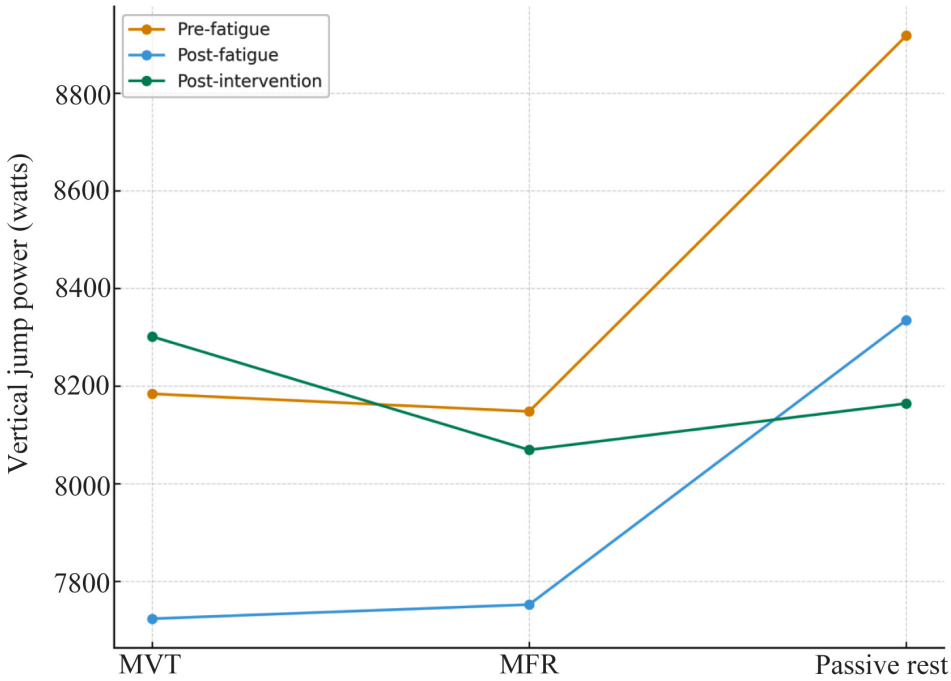


Figure 2. Changes in vertical jump power (VJP) across groups.

excitability, and central factors, such as decreased neural drive (21-23). Effective recovery strategies should target both components.

Both MVT and MFR improved subjective fatigue scores, which shows their impact on perceptual recovery. MFR improves soft tissue mobility, reduces tension, and boosts circulation (24,25), which can reduce perceived effort. MVT, besides promoting circulation, activates neurophysiological processes that probably explain its better results (26,27).

Performance restoration

Beyond circulation: Significant improvements in VJP were seen only in the MVT group. This shows

the difference between how recovery feels and actual performance. While MFR reduces discomfort and fatigue, it does not effectively stimulate the neuromuscular system to quickly restore explosive power. The better effects of MVT come from several mechanisms, not just increased blood flow. Vibration stimulates muscle spindles and improves motor unit recruitment and synchronization, which boosts force production (28,29). It also elicits the tonic vibration reflex, generating involuntary yet controlled muscle contractions that help maintain neuromuscular readiness (28,29). Additionally, activation of mechanoreceptors enhances proprioceptive feedback, improving sensory input, motor control, and coordination (28,29). Vibration may further modulate the central nervous system, increasing cortical excitability and reducing central fatigue to improve neural drive (28,29). Finally, the mechanical vibrations can speed up recovery by improving lymphatic flow, helping clear out metabolites, and triggering molecular signals related to tissue recovery (24,25).

In contrast, MFR primarily acts on soft tissue and circulation (30,31). Passive rest offered minimal recovery, emphasizing the importance of active strategies (38,39).

Comparison with previous literature

The findings of the present study match earlier studies on vibration therapy. Chu *et al* (32) found less fatigue and better recovery markers after long-term vibration training in elite athletes. Xie *et al* (33) demonstrated immediate benefits of vibration in reducing exercise-induced fatigue. Page *et al* (34) highlighted enhanced proprioception and cortical activation as mechanisms underlying improved performance.

Evidence supports MFR for flexibility, pain relief, and functional outcomes (35,36). Castro-Sánchez *et al* (37) reported reductions in perceived exertion and improvements in short-term well-being occurred with manual therapy. However, similar to this study, its effect on explosive performance recovery is limited. Passive rest, while commonly used, showed minimal effectiveness (38,39).

Clinical and practical implications

These results affect both athletic performance and rehabilitation. MVT offers a fast, non-invasive, and affordable method for restoring performance while lowering feelings of fatigue. This is especially helpful when quick recovery is necessary between training sessions or competitions.

MFR continues to be beneficial for relieving perceived fatigue, improving flexibility, and providing therapeutic interaction. However, it should be used alongside methods that promote neuromuscular performance. Relying solely on passive rest is not enough. Combining active methods like MVT or MFR with organized rest may lead to better recovery results.

Strengths of the study

This study has several notable strengths. It employed a randomized controlled design with an adequate sample size (n=90), which enhances the internal validity of the findings. The fatigue protocol was standardized using validated sprint-jump methods that are directly relevant to athletic performance (40). Furthermore, the study incorporated a comprehensive outcome assessment, including both subjective measures (VAS-F) and objective performance measures (VJP), allowing for a thorough evaluation of recovery. Finally, blinded outcome assessment was implemented to minimize measurement bias and improve the reliability of the results.

Limitations

Despite its strengths, this study has some limitations. It included only young, healthy adults, limiting its applicability to older adults, clinical populations, or elite athletes. The interventions were administered only once in an acute setting, so long-term or repeated-session effects are unknown. Participants and therapists could not be blinded due to the nature of the treatments, which may have introduced expectation bias. Additionally, the study did not include biochemical markers of fatigue (*e.g.*, blood lactate, creatine kinase), which could have provided more objective insights into physiological recovery.

Future directions

Future research should focus on evaluating the long-term effects of repeated MVT and MFR sessions in both athletic and rehabilitative groups. Additional

studies that include other recovery techniques like cryotherapy, compression, or active recovery exercises would clarify the relative effectiveness of these methods. Using physiological markers, advanced imaging, and electromyography may also shed light on the underlying mechanisms. Moreover, exploring the optimal dosage (frequency, duration, and intensity) of MVT could improve practical applications for coaches, athletes, and clinicians.

Conclusion

This randomized controlled trial looked at the immediate effects of MVT, MFR and passive rest on muscle fatigue recovery and performance in healthy young adults. The findings show that MVT was more effective than both MFR and passive rest in reducing perceived fatigue and restoring vertical jump power. While MFR also lowered fatigue perception, it did not significantly improve performance. Passive rest, though often used as a recovery method, showed minimal short-term benefits.

These results suggest that MVT offers a dual benefit by reducing subjective fatigue and improving objective neuromuscular performance, making it a useful tool for athletic recovery and rehabilitation routines. MFR may still help when the main goals are to reduce discomfort and improve tissue mobility. However, relying solely on passive rest seems inadequate for quick recovery from acute fatigue.

Future research should explore the long-term effects, optimal treatment levels, and the relevance of these methods for different groups, including athletes, older adults, and clinical populations.

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Conflict of Interest

The authors declare that there are no conflicts of interest related to this manuscript.

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