Original Article

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TANAFFOS

Efficacy of Massage and Range-of-Motion Exercises on Acquired Weakness in the Critical Care Unit: A Single-Blind Randomized Parallel Controlled Clinical Trial

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Background: Muscle atrophy and weakness are major problems in intensive care units (ICUs). The goal of this study was to assess the effects of massage and range-of-motion (ROM) exercises on ICU-acquired weakness (ICU-AW).

Materials and Methods: We randomly allocated 90 conscious patients admitted to ICUs to one of three groups using block randomization: massage, ROM exercises, or control. The researcher gave the massage group members daily Swedish massages for seven days. They also performed a range-of-motion (ROM) exercise program on both the upper and lower extremities once daily for 7 days. The co-researcher used the Medical Research Council Sum Score (MRC-SS) to assess the Critical Care Unit-Acquired Weakness (ICU-AW) at various time points: before the intervention, on the fourth and seventh days of the intervention for the intervention groups, and on the first, fourth, and seventh days of admission at 8 pm for the control group.

Results: Following the intervention, the massage group showed a significant increase in muscular strength. Following the intervention, both the massage and ROM exercise groups exhibited substantially higher muscular strength than the control group ($P<0.05$). Furthermore, after the intervention, the ROM exercise group displayed a larger gain in muscular strength than the massage group (mean difference=3.23, SE=1.05, p=0.01).

Conclusion: The current study found that ROM exercises and massage were both effective therapies for preventing or improving ICU-AW in patients admitted to the ICU.

Keywords: ICU-Acquired weakness; Range of motion exercises; Massage therapy; Muscle strength recovery; Critical care rehabilitation

INTRODUCTION

The critical care unit (ICU) is a specialized hospital department providing intensive care for critically ill patients (1). Prolonged ICU stays often result in neuromuscular complications, reduced physical performance, and mental health decline (2–5). ICU-acquired weakness (ICU-AW) is a common condition affecting critically ill patients, leading to muscle atrophy, loss of mass, and significant functional impairments (6–9). This condition affects approximately half of ICU patients, with an even higher prevalence (67%) in those undergoing mechanical ventilation for more than ten days (10).

Symptoms include proximal muscle weakness, facial and ocular paralysis, reduced reflexes, and respiratory complications (10, 11).

Several risk factors contribute to ICU-AW, including immobilization, infections, multiple organ failure, hyperglycemia, corticosteroid use, and inadequate nutrition (6,8). ICU-AW is associated with prolonged hospitalization, higher healthcare costs, increased mortality rates, and long-term disability (7–10,12). Despite its significant impact, no specific treatment exists, making early intervention crucial (8). Studies suggest that rehabilitation within the first 48–72 hours of ICU admission can reduce the incidence of ICU-AW by 37–39% (13,14).

Various interventions have been explored to mitigate ICU-AW, including electrical muscle stimulation, massage therapy, and range of motion (ROM) exercises (2,14,15). Swedish massage, a widely used technique, offers benefits such as pain relief, improved circulation, muscle relaxation, and enhanced neuromuscular function (16–19). ROM exercises, which involve active, passive, and assisted movements, are essential for maintaining joint flexibility, blood flow, and synovial fluid movement, thereby preventing muscle stiffness and atrophy (20, 21).

Several studies have assessed different muscle stimulation methods for ICU-AW prevention. Early rehabilitation has been linked to lower ICU-AW incidence and improved hospital discharge rates (13). Techniques such as belt electrode skeletal muscle electrical stimulation (B-SES) and whole-body vibration therapy have shown promise in preserving muscle mass and metabolism (22,23). Passive cycle ergometry has also demonstrated positive effects on muscle morphology in mechanically ventilated patients (24).

However, some interventions have yielded mixed results. Studies on passive tilting and neuromuscular electrical stimulation (NMES) have shown limited effects on muscle strength and function (25,26). While muscle electrical stimulation may not fully prevent ICU-AW, it can reduce muscle weakness and facilitate weaning from mechanical ventilation (27).

Given the serious consequences of ICU-acquired weakness (ICU-AW) in hospitalized patients, finding effective, safe, and cost-efficient strategies for preventing and improving this condition is of great importance. While some interventions, such as electrical muscle stimulation and exercise therapy, have been studied, there is insufficient evidence on the effectiveness of non-invasive, accessible methods like massage and range-of-motion (ROM) exercises. Previous studies have shown that physiotherapy exercises and muscle stimulation can be effective in reducing this condition. However, no study has yet examined the combined effect of massage and ROM exercises on ICU-AW. By investigating the impact of these two methods on the muscular strength of ICU patients, this study can contribute to a better understanding of rehabilitation strategies and serve as a basis for developing effective treatment protocols to reduce the complications associated with prolonged ICU hospitalization.

MATERIALS AND METHODS

Study setting

We conducted a single-blind, randomized, parallel-group controlled clinical study of conscious patients admitted to the ICU at Afzalipour Hospital in Kerman, southeast Iran.

Sample size and sampling

The participants were divided into three groups based on gender and age. The groups were labeled as A (massage), B (control), and C (range-of-motion exercises). The inclusion criteria included patients over the age of 18 admitted on the first day, including those receiving invasive mechanical ventilation, non-invasive mechanical ventilation, or other ICU patients. 87 individuals would be needed to detect an effect size of 0.28, power=80%, and p=0.05 (power analysis estimations). A total of 109 eligible individuals were split into three groups (Figure 1). The sampling period lasted from June to November 2020.

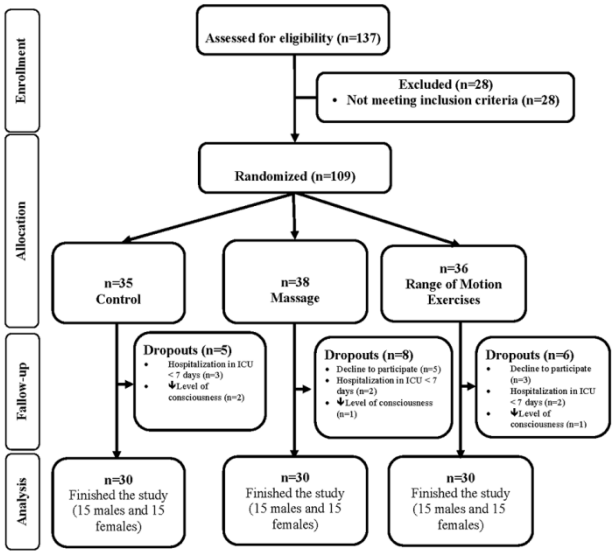


Figure 1. The flow diagram of the study

Data collection and outcome measures

A questionnaire was used to collect demographic and background information, including age, gender, ward, and length of hospital stay before ICU admission. In this study, muscle strength was assessed using the Medical Research Council sum score (MRC-SS). The MRC-SS employed a manual muscle test to measure muscular strength in the upper and lower limbs. The score for each muscle group goes from 0 to 5. Sixty is the optimal score, with anything below 48 indicating ICU-AW (5,14). The rater, who was also a co-researcher, learned the MRC scale during three two-hour sessions with the help of a physiotherapist to assess interrater reliability. He considered seeking permission from an expert. The rater was not involved in any way. The rater evaluated 15 patients hospitalized in Afzalipour Hospital's intensive care unit twice (at 2-hour intervals). The ICC ($p<0.001$ and CI=0.999 - 0.992) was 0.99. In addition, the FOUR (Full Outline of Unresponsiveness) scale and the SOFA (Sequential Organ Failure Assessment) score were used to assess the patients' condition. The FOUR scale served as a precise tool for measuring the level of consciousness in ICU patients, while the SOFA score was used to evaluate organ function and the severity of organ failure. These two measures helped the researchers to comprehensively assess the patients' condition and examine the relationship between muscle function and their clinical status.

Procedure

The researcher first obtained permission to conduct the study from the hospital and ICU management. She then referred patients to intensive care units (ICUs), obtained written informed consent before intervention, and collected demographic and background information from patients who met the inclusion criteria.

Massage group

Patients in the massage group had their entire bodies massaged (using the Swedish method) once a day for 7 days. In supine posture, the patient's head was at a 30-45-degree angle. Olive oil (about 20 cc) was applied to the area being massaged. From 3:00 to 7:00 pm, the upper and lower limbs, back, and chest were massaged for 30-60 minutes (28).

A co-researcher performed the massage for male participants, while the researcher massaged the female participants.

Range-of-motion exercise group

Passive, active, and active-assistive ROM exercises were performed once daily for 7 days. The researcher changed the patients' posture (from supine to upright) based on body mechanics. Based on the patient's condition, the researcher performed passive, active, and active-assistive ROM exercises (smoothly and rhythmically with 10 repetitions) for 30 to 60 minutes (20). ROM exercises lasted 30 to 60 minutes (Appendix) and were conducted at 3:00 and 7:00 pm (28). Before commencing the research, the researcher was trained for three sessions (6 hours) in ROM exercises in collaboration with the physiotherapist, and the intervention began following permission.

Routine care group

The group that received standard treatment underwent no additional intervention. Normal treatment for ICU patients comprised respiratory and extremity physiotherapy (done by a physiotherapist once a day) (Appendix).

Statistical analysis

Descriptive statistics were used to characterize the patients' demographics and clinical histories. To compare MRC scores, the Bonferroni post hoc test was used. The Chi-square and Friedman tests were used to compare the frequency of ICU-AW within and among groups. In addition, multivariate logistic regression was used to control for the confounding effect of the MRC score before the intervention.

Ethics approval and consent to participate

The current study was carried out after obtaining an ethics code (IR.KMU.REC.1398.558) from Kerman University of Medical Sciences and a clinical trial code (IRCT20200203046358N1) from the Iranian Registry of Clinical Trials, coordinating with the manager and head of Afzalipour Hospital, and obtaining informed consent from eligible patients.

RESULTS

Baseline Characteristics of the Participants

The massage and range-of-motion exercise samples had mean ages of 46.67 and 17.24 years and 44.27 and 13.61 years, respectively (F = 0.31, p = 0.73). Gender, ICU type, length of stay in hospital before ICU admission, diagnosis, and history of addiction, chronic illness, ICU admission, and hemodialysis usage were all homogeneous (p > 0.05). There were no significant differences in nutrition route (NPO, PO), nutrition regimen (regular, diabetic, etc.), respiratory support (face mask, nasal cannula, mechanical ventilation, high-flow nasal cannulation, and so on), and medication regimen (p>0.05), which included narcotics, sedatives, antibiotics, cardiovascular and antihypertensive drugs, supplements, antivirals, respiratory and gastrointestinal ones, and corticosteroids. All patients received an average GCS score of 15. The samples in the massage, range-of-motion exercise, and control groups had mean APACHE scale scores of 7.67 (3.43), 3.43, 7.53 (3.86), and 8.50 (3.63), respectively (F = 0.62, p = 0.54).

In the massage group, ROM group, and control group, the FOUR (Full Outline of Unresponsiveness) scores increased from T1 to T3, and this increase was statistically significant (P<0.001). But the results of ANOVA showed that there was no statistically significant difference in the FOUR scores at T1, T2, and T3 between the three groups (P>0.05) (Table 1).

Table 1. Comparison of FOUR scores between the three groups: massage, range-of-motion exercise, and control

Time	FOUR score at T_1		FOUR score at T_2		FOUR score at T_3		Repeated Measures ANOVA	Effect size	*p* value
Group	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**			
Massage	14.9	0.8	15.33	0.61	15.93	0.25	41.92	0.59	< 0.001
ROM exercise	14.83	0.59	15.36	0.57	15.90	0.31	59.87	0.67	< 0.001
Control	15.13	0.68	15.50	0.57	15.96	0.18	31.84	0.52	< 0.001
ANOVA	1.53		0.65		0.52				
***p* value**	0.22		0.52		0.59				

FOUR: Full Outline of Unresponsiveness; T1 stands for before intervention; T2 stands for during intervention; and T3 stands for after intervention.
ANOVA: Analysis of variance; ROM: range of motion; SD: Standard deviation

Table 2. Comparison of SOFA scores between the three groups: massage, range-of-motion exercise, and control

Time	SOFA score at T_1		SOFA score at T_2		SOFA score at T_3		Repeated Measures ANOVA	Effect size	*p* value
Group	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**			
Massage	2.43	1.25	1.63	1.07	0.67	0.88	86.67	0.75	< 0.001
ROM exercise	2.07	1.44	1.37	1.30	0.50	1.33	45.20	0.61	< 0.001
Control	2.03	1.25	1.17	1.18	0.50	0.78	77.92	0.73	< 0.001
ANOVA	0.56		1.17		0.26				
***p* value**	0.43		0.32		0.77				

SOFA: Sequential Organ Failure Assessment; T1 stands for before intervention; T2 stands for during intervention; and T3 stands for after intervention.
ANOVA: Analysis of variance; ROM: range of motion; SD: Standard deviation

In the massage, ROM, and control groups, the SOFA (Sequential Organ Failure Assessment) scores decreased from T1 to T3, and this reduction was statistically significant (P<0.001). But there was no statistically significant difference in the SOFA scores at T1, T2, and T3 between the three groups (P>0.05) (Table 2).

Main outcome

The MRC score increased after intervention in the massage and ROM exercise groups but decreased significantly (p<0.001) in the control group (Table 3). Furthermore, Bonferroni post hoc testing indicated that the MRC scores differed among the three groups. MRC scores in the ROM exercise group, on the other hand, were greater than those in the massage group, and MRC scores in the massage group were higher than those in the control group (p<0.001).

Before the intervention, the frequencies of ICU-AW were 19 (63.3%), 25 (83.3%), and 14 (46.7%) in the massage, ROM exercise, and control groups, respectively. Still, after the intervention, the frequencies of ICU-AW were 6 (20%), 1 (6.7%), and 28 (93.3%), respectively (Table 4). In addition, multivariate logistic regression was used to control the confounding effect of the MRC score before the intervention. The ICU-AW was considered an independent variable, while the group and the MRC score before the intervention were considered dependent variables. The findings revealed that ICU-AW varied significantly among the three groups during the intervention (i.e., at T2). However, at T2, the incidence of ICU-AW was significantly lower in the massage and ROM exercise groups than in the control group (p<0.05).

Table 3. Comparison of Medical Research Council (MRC) scores between the three groups: massage, range-of-motion exercise, and control

Time	MRC score at T_1			MRC score at T_2			MRC score at T_3			Repeated Measures	*p* value	Mean difference (T3-T1)	
Group	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	ANOVA		Mean	SD
Massage	48.0	47.87	5.01	50.0	50.03	5.50	52.0	53.0	4.62	52.48	<0.001	5.13	3.31
ROM exercise	45.0	44.83	4.58	50.0	49..83	3.63	56.0	56.23	3.46	263.69	<0.001	11.40	2.82
Control	50.0	52.07	4.50	48.0	48.43	8.08	44.0	43.40	4.84	203.19	<0.001	-8.67	2.29
Statistical test		17.90*			1.92**			55.92**				392.23*	
***p* value**		< 0.001			0.38			< 0.001				< 0.001	

MRC: Medical Research Council; T1 stands for before intervention; T2 stands for during intervention; and T3 stands for after intervention. ROM: range of motion; SD: Standard deviation.

* Analysis of variance

** Kruskal-Wallis's test

Table 4. Comparison of Critical Care Unit Acquire Weakness (ICU-AW) between the three groups: massage, range-of-motion exercise, and control at different times

Time		ICU_AW at T_1		ICU_AW at T_2		ICU_AW at T_3		Friedman test	*p* value
Group		N	%	N	%	N	%		
Massage	Yes	19	63.3	13	43.3	6	20.0	19.54	< 0.001
	No	11	36.7	17	56.7	24	80.0		
ROM exercise	Yes	25	83.3	11	36.7	1	6.7	36.33	< 0.001
	No	5	16.7	19	63.3	29	93.3		
Control	Yes	14	46.7	18	60.0	28	93.3	22.29	< 0.001
	No	16	53.3	12	40.0	2	6.7		
Chi-square test		8.82		3.48		57.88			
***p* value**		0.01		0.18		< 0.001			

ICU-AW: Critical Care Unit Acquire Weakness; T1 stands for before intervention; T2 stands for during intervention; and T3 stands for after intervention. ROM: range of motion

DISCUSSION

According to the current study's findings, ICU-AW was present in 63.3% of the massage group, 83.3% of the ROM exercise group, and 46.7% of the control group before intervention. The frequency of ICU-AW samples in the control group was significantly lower than in the massage and ROM groups before the intervention. Only 20% of the massage group samples and 6.7% of the ROM exercise group samples had ICU-AW after the intervention, whereas 93.3% of the control group samples had ICU-AW. When the influence of the MRC score before intervention was adjusted for, the incidence of ICU-AW in the ROM and massage groups increased. The group was much lower than in the control group. Yosef-Brauner et al. showed that intensive physiotherapy treatment (ROM exercises, posture modification, breathing exercises, active exercises involving all limb joints, bed mobility training, and secretion suctioning) might assist patients with ICU-AW to recover more quickly (29). Verceles et al. observed that, compared with standard care, multimodal rehabilitation programs enhanced muscular strength, mobility, successful weaning from the ventilator, and hospital discharge among ICU patients (30). In a systematic review and meta-analysis, Anekwe et al. found that early rehabilitation was associated with a decreased risk of ICU-AW and a greater likelihood of hospital discharge (13). Liu et al. found that neuromuscular electrical stimulation (NMES) intervention might prevent ICU-AW and enhance quality of life in ICU patients by increasing muscle strength and lowering MV duration, ICU length of stay, and overall hospital stay in a meta-analysis research (31). According to Nakamura et al., belt electrode skeletal muscle electrical stimulation (B-SES) decreased muscle volume loss in ICU-AW patients (22). Wollersheim et al. showed that whole-body vibration might be used to either prevent or cure ICU-AW (23). Although the treatments employed in the various studies are not identical, they are comparable to the current intervention in that they all stimulate and move muscles and joints. ROM exercises affect muscles, joint surfaces, ligaments, fascia, arteries, and nerves; mobilize joints, soft tissues, and muscles; reduce loss of tissue flexibility; and enhance muscular strength and hypertrophy (20,32). Early movement also reduces immobility time, improves venous return, increases the quantity of oxygen delivered to tissues, and improves muscle dysfunction (13).

An examination of the available literature indicated that several studies in this subject did not support the current study's conclusions. Sarfati et al., for example, examined the effectiveness of early inactive tilting in reducing ICU-AW among patients admitted to the open-heart Critical Care Unit. According to the data, inactive tilting added to usual therapy did not improve muscle strength in patients hospitalized in the open-heart Critical care unit (25). Patsaki et al. found that neuromuscular stimulation and customized therapy did not improve muscle strength and function in ICU survivors (26). Muscle electrical stimulation did not prevent ICU-AW among critically ill patients receiving mechanical ventilation. Still, it improved muscle weakness and facilitated weaning from mechanical ventilation, according to Abu-Khaber et al. (27). The differences between the current study and the studies by Sarfati et al. (25) and Patsaki et al. (26) may be related to the type of intervention and the study setting. The intervention in the current study is the impact of massage therapy and ROM exercises on ICU-AW (surgical, poisoning, medical, and corona). We could not find a study that looked at the effect of massage on muscular weakness. Massage stimulates the lymphatic system, boosts blood circulation, enabling more oxygen to reach organs, and increases the amount of blood moved between tissues due to tissue pressure. Massage increases permeability in capillary and muscle tissues, thereby improving muscle fiber flexibility and promoting muscular contraction (33). Given the mechanism of massage and the present study's findings, and in the absence of further data, more research is needed to confirm or refute the current study's conclusions.

Other studies, like this one, have indicated that muscle stimulation-based therapy is beneficial in the ICU-AW of

patients admitted to ICUs. Because ICU-AW is a significant and common complication in ICU patients (29), which causes muscle atrophy, prolonged muscle weakness, hyporeflexia, delayed rehabilitation, increased mortality, and a lower quality of life after hospital discharge, effective therapies are needed to reduce the prevalence of this illness in these individuals. Massage treatment and range-of-motion exercises are both effective methods for maintaining muscular strength.

CONCLUSION

Massage and ROM exercises may be useful in the prevention or treatment of ICU-AW. Massage and range-of-motion exercises can be quite helpful in avoiding or treating this condition in patients. It is recommended that ICU nurses devote time to administering these treatments to patients as part of their routine care. It is also advised that ROM exercises be conducted more regularly and correctly in ICUs. More study is needed to determine the efficacy of massage and ROM exercises on muscular weakness in ICU patients with diverse diseases and physical conditions.

Conflicts of interest

The authors declare no conflicts of interest. They have no relevant financial or non-financial interests to disclose.

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