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The Immediate Effects of Manual Massage of Forearm on Power-Grip Strength and Endurance in Healthy Young Men

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Abstract

Objective: The purpose of this study was to examine the immediate effects of a single massage session on hand grip strength and endurance after isometric exercise in healthy young men under controlled conditions.

Methods: A total of 44 healthy young men from a university population participated in the study. They were randomized to receive either massage or passive movement intervention. Hand grip endurance and hand grip strength in both groups were recorded using a Jamar hand grip dynamometer and a digital chronometer before and after the intervention. Statistical analysis was performed using the Wilcoxon, Mann-Whitney, and paired *t* test as well as independent *t* test.

Results: Pre-and postmean hand grip endurance times for the massage group were 38.4 ± 12 and 46.5 ± 13 seconds ($P < .001$), and hand grip strength values were 43 ± 5.6 and 45.7 ± 5.3 kg ($P = .077$). Pre-and postmean hand grip endurance times for the passive movement group were 33 ± 12.3 and 31.9 ± 10.7 seconds ($P = .513$), and hand grip strength values were 42.8 ± 6 and 42.9 ± 5.6 kg ($P = .854$).

Conclusion: Immediately after 1 session of massage to the forearm and hand, the grip endurance improved in a group of healthy young men. However, passive movement of the upper limb for 1 session did not enhance grip performance.

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Introduction

In many activities and sports, hand grip is important. Also, many jobs are greatly dependent on grip strength. Grip performance is necessary in activities such as carrying a suitcase, turning a doorknob, and many other tasks. Grip performance is also important in sports like tennis, basketball, and mountain climbing. In addition, researches in the field of rehabilitation, sports, and ergonomics often use hand grip evaluation.

Regarding the massage, it should be mentioned that, for thousands of years, massage has been in use; however, more recently, it has been used in rehabilitation.[1] Some literatures support a positive trend for massage to benefit athletic recovery and performance.[2] It has been reported that massage improved grip strength in the carpal tunnel syndrome.[3]The symptoms of carpal tunnel syndrome were also relieved by massage.[4] Another study showed that petrissage improved cycle ergometer pedaling performance.[5] Equally, several studies reported that massage decreased delay muscle soreness after vigorous exercise. Muscle soreness can negatively interfere with the activities of daily living as well as sports performance.[6–8] It has also been reported that the use of massage in women collegiate athletes decreased soreness and improved vertical jump.[9] Massage has been shown to be helpful in reducing pain and joint stiffness and improving function in patients with osteoarthritis of the knee over a period of 8 weeks.[10] In addition, a pain reduction in hand arthritis following massage was noticed.[11,12] Also, beneficial effects of massage to soothe anxiety[13] and boost immunity[14] have been reported. It is generally accepted that massage can provide benefits to the body such as reducing muscle pain; a 2011 study published in the *Annals of Internal Medicine* found that massage therapy is as effective as other methods of treatment for chronic back pain.[15]

Although in studies about the effect of massage on performance outcome variables such as grip performance,[16] sit and reach test,[17] lactate removal,[18] blood flow,[19] and electromyography[20,21] are usually investigated, the effect of massage on grip performance was examined in the present study. Besides the importance of grip in activities of daily living, jobs, and sports, some authors believe that grip may reflect the patient's general health and physical activity.[22] In some studies, impaired grip strength was considered as an indicator of increased postoperative complications, decreased physical status, and upper extremity trauma outcomes.[22,23] *Grip strength* is a general term used to describe the amount of power a person can generate with his or her hands.[24] However, in most activities, repeated or sustained grip is used rather than a single short grip. Most activities require repeated forceful dynamic grasping or prolonged static holding rather than exerting maximum force during a single repetition. This sustained muscle contraction is referred to as *endurance*. *Muscular endurance* is the ability of a muscle or group of muscles to sustain an isometric contraction or continue repeated contractions against a resistance for an extended period of time.[25] *Massage* is the manipulation of the superficial and deeper layers of the muscle and connective tissue using various techniques to enhance function, decrease muscle reflex activity, aid in the healing process, and inhibit motor-neuron excitability.[26] Although it is generally accepted that massage can provide benefits to the body, other studies have reported that massage has no positive effect on performance.[27–30] Therefore, more studies are needed to clarify the effects of massage on performance.[31] The objective of this study was to determine if 1 session of hand and forearm massage could improve hand grip strength and endurance in healthy young men.

Methods

Subjects

After a public announcement through posters on campus, healthy young men from a university population entered the study. In the present study based on history and individual's self-assessment, the participant was considered as healthy or unhealthy. The following items were considered as inclusion and exclusion criteria: healthy male subjects (age, 18-25 years; body mass index [BMI], 22-25 kg/m^2) with no history of upper extremity injury, trauma, or dysfunction for the past year. None of the subjects was an athlete (exercise was performed not more than once a week), and none had received massage for the past month. However, if the participants had a limited range of motion or were not interested in completing the test procedure, they were excluded. Every subject with a BMI between 22 and 25 kg/m^2 was registered. Afterward, the individual was randomly allocated to either the massage (n = 22) or passive movement (n = 22) group (based on simple random allocation using the biased coin suggested by Fleiss[32]).

In total, 53 subjects were enrolled for the test. Four subjects were omitted because they were athletes, and 2 subjects were omitted because their BMI was not in the desirable range. Three subjects were also omitted as a result of sustaining upper limb injury in the past year.

The participants were asked to complete a form that included name, age, weight, height, dominant hand (the hand used for writing), address, and phone number. The test procedures were fully explained to the subjects, and all the subjects signed written informed consent before the test commenced. The study was approved by the Ethics Committee of the international branch Shahid Beheshti University of Medical Sciences (registration no.: 11601060). Sample size was determined based on the study of Brooks et al (2005)[16] and by the following formula:

$$n = \frac{2(Z\partial + Z\beta)^2 S^2 \rho}{(\mu 1 - \mu 2)^2}$$
$$\partial = 0.05$$
$$\beta = 0.1$$
$$\mu 1 - \mu 2 = 4$$
$$S\rho = 4.1$$
$$n = \frac{2(1.96 + 1.28)^2 (4.1)^2}{(4)^2}$$
$$n = 22$$

Massage Group

Massage intervention consisted of deep effleurage and kneading for the dorsal and ventral surfaces of the forearm and hand for 5 minutes. The massage was performed with the subject in the supine position with his upper limb leaning against the bed. While the forearm was in pronation, the massage began with stroking the hand up to the elbow with moderate pressure and back down. This technique was performed 30 times at the rate of 1 stroke per second. At that point, circular palmar kneading was applied to the same area for 45 seconds, and the massage was performed twice. These techniques were performed on the dorsal surface of the forearm and hand. Then, the forearm was placed in supinaton, and the same techniques with the same rate were performed for the ventral surface of the forearm and hand. The massage covered the entire forearm and hand with each dorsal and ventral surface of the forearm and hand receiving massage for 2.5 minutes. A physical therapist experienced in massage performed hand and forearm massage for all subjects. Other types of massage such as myofascial release or shiatsu were not allowed.

Passive Movement Group

Passive movement was performed for the shoulder, elbow, forearm, wrist, and fingers. Each joint was moved within its normal limits. For subjects in the passive movement group, upper limb passive movement was done with the subject in the supine position and his upper limb leaning against the bed. There was no pain or range of motion limitation in the shoulder, elbow, forearm, wrist, and fingers. Passive movements were done within the normal limits of each joint. Passive range of motion including flexion, extension, abduction, adduction, and internal and external rotation was done on the shoulder. Then, passive flexion and extension of the elbow was done. After that, passive supination and pronation of the forearm was performed. Finally, flexion, extension, abduction, and adduction were done on the wrist and fingers.

While the subject was supine, each movement was passively performed 5 times. For example, the shoulder was passively "flexed-extended" 5 times, "abducted-adducted" 5 times, and "medially-externally rotated" 5 times. However, for internal and external rotation of the shoulder, the individual's arm and elbow were positioned at 90° abduction and 90° flexion, respectively. Also, the elbow was passively "flexed-extended"5 times. In this way, the forearm was passively supinated-pronated 5 times. The wrist was passively "flexed-extended" 5 times and "abducted-adducted" (radial and ulnar deviation) 5 times. The fingers were passively "flexed-extended" 5 times and "abducted-adducted" 5 times. The passive movement performance took 5 minutes. On the other hand, each participant in the passive movement group received a passive range of motion for 5 minutes. During the passive movement, participants were asked to remain relaxed.

Measurement of Hand Grip Strength and Hand Grip Endurance

The subjects entered the laboratory at the same time of day to minimize the possible interference of circadian rhythm.[33,34] Hand grip measurement was performed for the dominant hand (the hand used for writing.) For familiarization, the test was first done on the nonintervention hand. The real test began after 10 minutes of rest. The researcher clearly explained the test protocol to each participant. Before and after the intervention (massage or passive movements), hand grip strength and hand grip endurance of the dominant hand in both groups were measured using a JAMAR 5030 J1 hydraulic dynamometer (Sammons Preston Inc, Bolingbrook, IL) and a digital chronometer. The hand dynamometer and digital chronometer were examined for calibration before starting the test. Many studies have suggested an acceptable reliability and validity for hand dynamometry provided a true technique is considered.[35–37] A light warm-up was performed by the subjects before being comfortably seated in a standardized measurement position, as recommended by the American Society of Hand Therapists: In this standard position, the test shoulder is adducted and neutrally rotated, elbow flexed at 90°, forearm in neutral, and the wrist in slight extension and ulnar deviation. The subjects held the 1.4-lb calibrated hand dynamometer with the readout dial facing away. The participants were asked to squeeze the handle of the dynamometer with maximum strength with the extremity in the standard position. The subjects kept the maximal voluntary contraction for at least 3 seconds. They squeezed the dynamometer thrice, and the average was considered as baseline grip strength in pounds; then obtained values were converted to kilograms. Participants were verbally encouraged to squeeze the dynamometer with their maximum effort. Hand grip endurance was measured by the number of seconds a subject maintained a certain percentage of his or her maximal grip strength. Therefore, to determine the hand grip endurance, the dynamometer peak hold needle was put at 60% of baseline grip strength. The subjects were asked to hold the dynamometer needle for as long as they could in such a way that they were no longer able to keep maintaining the needle for more than 5 seconds as the task became extremely difficult. The duration of time for which each subject kept the dynamometer needle was regarded as endurance time and recorded in seconds using a digital chronometer. To measure hand grip strength and hand grip endurance, the examiner recorded test score when he believed that the subject had exerted maximum effort. After determining hand grip strength and hand grip endurance, the subjects were given 3 minutes for rest and active recovery.

Active recovery refers to recovering from an exercise using a low-intensity activity. It has been suggested that active recovery clears accumulated blood lactate faster than passive recovery.[40]

The general theory is that low-intensity activity assists blood circulation which, in turn, helps remove lactic acid from the muscle. Low-intensity active recovery appears to significantly reduce accumulated blood lactate and speed muscle recovery.[39] Also, according to Riganas et al, in elite male rowers, the active recovery provided higher rate of lactate removal compared with passive recovery.[38] Also, it was reported that active recovery immediately after the event encourages recovery and reduces muscle lactate levels faster than complete rest.[41]

In the present study, the active recovery interval was followed by either 5-minute massage or upper limb passive movement. After the intervention, the subjects rested for 5 minutes. Then, postintervention measurements for hand grip strength and hand grip endurance were performed for the massage and passive movement groups. The same physiotherapist performed intervention and data collection for both groups in a single session. Test conditions, regarding room temperature (25°C) and the time of the day (between 8:00 and 11:00 AM), were the same for all subjects. Fig 1 shows a flowchart for the study.

Statistical Analysis

Data were analyzed using PASW SPSS18. Mean and standard deviation for each variable of the values were calculated. Distribution patterns of the strength and endurance variables were not the same. Variables with normal distribution were compared using independent-sample *t* test and paired-sample *t* test.

However, to compare the variables that did not show normal distribution, Wilcoxon signed rank test and Mann-Whitney test were used.

Results

Forty-four healthy young men who met the study inclusion criteria participated in the study. According to the inclusion criteria, all the participants had a BMI score between 22 and 25 kg/m^2. The comparison indicated that there were no differences between the 2 groups for BMI, height, and weight. Also, statistical analysis revealed no significant differences for hand grip strength and hand grip endurance between the 2 groups before intervention. A pre and post comparison of the endurance variable in the massage group with paired-sample *t* test revealed a statistically significant improvement ($P < .001$). In addition, postintervention comparison between the 2 groups for the endurance variable using Mann-Whitney test was statistically significant ($P < .0005$). Regarding the strength variable, after performing the massage, the strength variable increased in the massage group; however, this improvement was not statistically significant ($P < .077$). In the passive movement group, no improvement in endurance and strength variables after performing the passive movement was noticed ($P = .513$ and $P = .854$, respectively). Also, postintervention comparison between the 2 groups for the strength variable was not

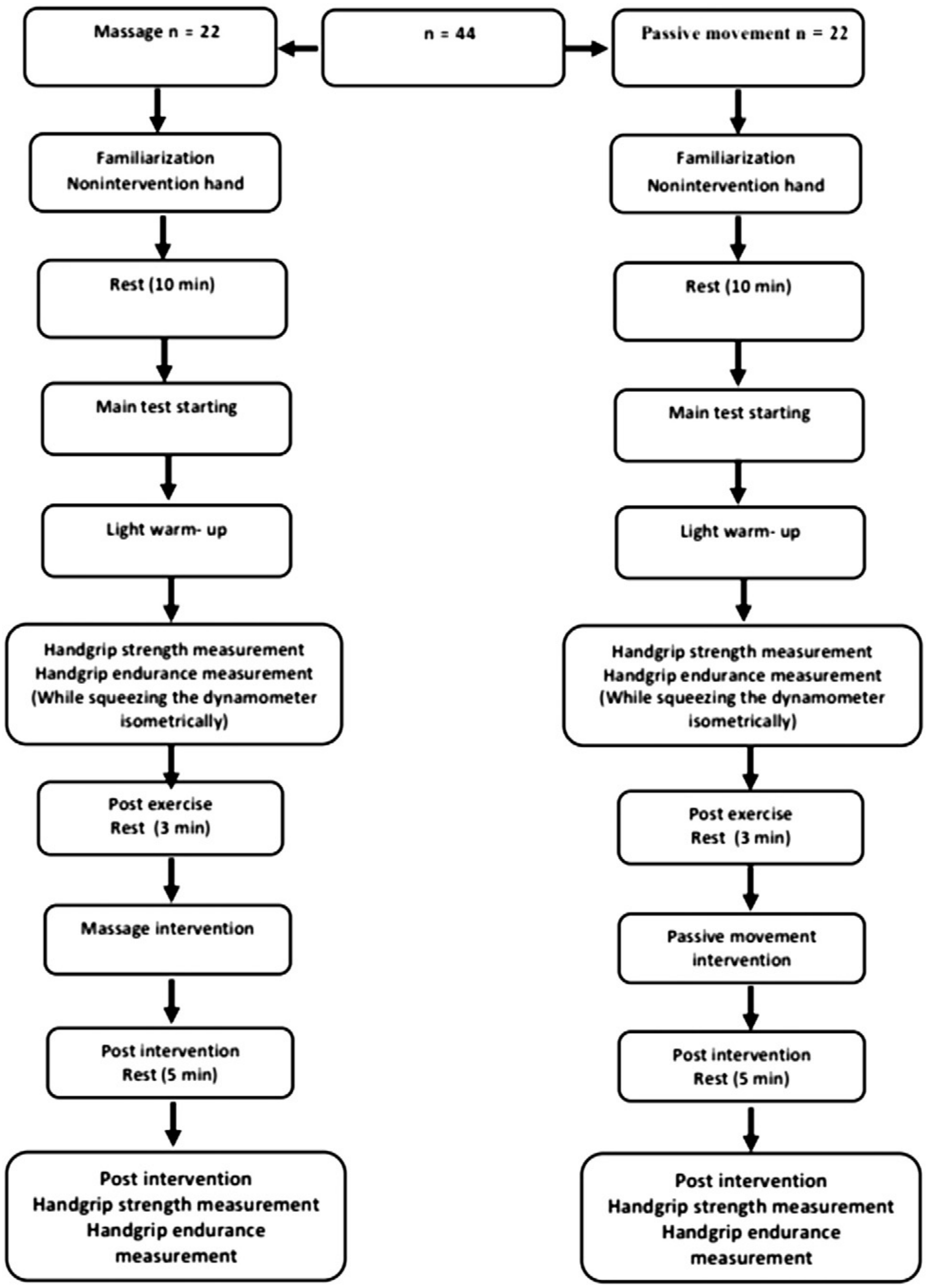

Fig 1. Test procedures flowchart.

statistically significant (*P* = .067; for all statistical tests, α was set at 5%). Table 1 summarizes the demographic characteristics and hand grip measurement scores.

Table 2 presents comparisons of preintervention and postintervention values for hand grip strength and hand grip endurance in both groups. Because the test protocol was not difficult and did not take too much time, all the participants completed the test procedure.

Table 3 presents the preintervention and postintervention values for hand grip endurance and hand grip strength in both groups.

Discussion

This study investigated the immediate effects of forearm and hand massage on grip strength and endurance. To determine their maximum voluntary contractions, 44 healthy male subjects in 2 groups (n = 22) squeezed a hydraulic dynamometer with maximum effort. Then their maximum voluntary contraction, grip strength, and grip endurance were measured before and immediately after the intervention (massage or passive movement). After the massage, participants in the

Table 1 Demographic and Grip Characteristics Values of Both Groups Before the Intervention

	Massage Group (n = 22)	Passive Movement Group (n = 22)	
	Mean (SD)	Mean (SD)	*P* Value
Age (y)	21.5 (1.9)	21.5 (2)	.892
Height (cm)	177.4 (6)	177.7 (6)	.854
Weight (kg)	72.8 (6.4)	73.1 (5)	.855
BMI (kg/m^2)	23.1 (1)	23.2 (0.8)	1.00
Hand endurance (s)	38.4 (12)	33 (12.3)	.088
Hand grip strength (kg)	43 (5.6)	42.8 (6)	.903

BMI, body mass index; *SD*, standard deviation. The values are the mean (SD) for hand grip endurance, hand grip strength, BMI, age, weight, and height.

massage group showed a statistically significant improvement in endurance. Also, postintervention comparison between both groups revealed a statistically significant difference for endurance. Although the grip strength after the massage increased, it was not statistically significant. However, no improvement in grip strength and endurance was noticed in the passive movement group after performing passive movement. The results of the present study support the findings of previous studies about the positive effect of massage on grip performance.[16] The study of Brooks et al (2005) showed immediate improvement in grip strength in healthy adults after massage. However, in the present study, in addition to grip strength, grip endurance was investigated and implied that, immediately after the massage, improvement in grip endurance was more noticeable than improvement in grip strength.

One possible explanation may be due to differences between the 2 types of muscle contractions during performance of grip strength and grip endurance. During the endurance test, participants were asked to keep their submaximal contractions as long as possible. However, during the strength test, it was required that participants keep their maximal contractions only for 3 seconds. Therefore, it would not be unlikely that the difference in mechanisms that supply muscle energy during these 2 types of muscle contractions (strong and short duration contraction for grip strength vs moderate and rather long duration contraction for grip endurance) causes the massage to be more effective for submaximal sustained contraction (endurance).

Massage is widely used in sports and rehabilitation. However, there are different reports about the effects of massage on performance. Some authors reported that massage has no effect on performance. They believe that massage neither improves nor prevents muscle performance.[17,21,29–31] In contrast, many studies reported improvement in muscle performance following massage.[2–5,9–12,22,23] It appears that factors such as target muscles, immediate or long-term effects, and athletic participants or nonathletic participants may influence the effectiveness of massage on muscle performance. In the present study, massage was not used for large muscles; rather, it was applied to the forearm and hand muscles. It is rather difficult to ensure that large muscle groups receive adequate contacts, whereas providing effective contact for small muscle groups is convenient. Because of the fact that muscles of the hand and forearm are small, these muscles received more effective contact. Because both intrinsic hand muscles as stabilizers and extrinsic forearm muscles—flexors as movers and extensors as stabilizers—were

Table 2 Comparisons of Preintervention and Postintervention Values for Hand Grip Endurance and Hand Grip Strength in Both Groups

	Endurance (s) Mean (SD)			Strength (kg) Mean (SD)		
	Pre	Post	*P* Value	Pre	Post	*P* Value
Massage (n = 22)	38.4 (12)	46.5 (13)	.001 [a]	43 (5.6)	45.7 (5.3)	.077 [c]
Passive movement (n = 22)	33 (12.3)	31.9 (10.7)	.513 [a]	42.8 (6)	45.9 (5.6)	.854 [a]
P value	*P* = .088 [d]	*P* < .0005 [d]		*P* = .903 [b]	*P* = .067 [d]	

The values are the mean (SD) for hand grip endurance and hand grip strength.

[a] Obtained from paired *t* test.

[b] Obtained from independent *t* test.

[c] Obtained from Wilcoxon signed ranks test.

[d] Obtained from Mann-Whitney test.

Table 3 Preintervention and Postintervention Values for Hand Grip Endurance and Hand Grip Strength in Both Groups

	Preintervention				Postintervention			
	Massage Group		Passive Movement Group		Massage Group		Passive Movement Group	
	Endurance (s)	Strength (kg)	Endurance (s)	Strength (kg)	Endurance (s)	Strength (kg)	Endurance (s)	Strength (kg)
1	53	48.9	58	40.1	70	50.7	43	40.1
2	55	41.7	32	47.9	45	46.2	23	48.5
3	30	35.8	27	49.8	45	38	24	50.2
4	44	38.5	25	51	40	48.5	24	44.5
5	48	42	30	44.5	50	44.8	33	42.1
6	45	43	24	44.5	45	44.8	22	44.7
7	31	44.1	50	53.9	35	49.1	40	54.4
8	62	46.2	50	44.4	65	48.7	45	43.5
9	37	46.9	29	45.3	40	48.5	27	50.3
10	25	55.7	35	36.2	30	46.9	54	41.2
11	50	44	18	46.2	80	46.7	20	42.6
12	50	48.5	30	42.6	50	51.6	27	41.2
13	45	48	20	38.5	55	49.4	22	35.8
14	28	39.9	26	46.2	45	40.3	22	47.1
15	33	45.8	34	38.5	44	50.7	36	36.7
16	25	35.8	25	44.8	45	41.2	27	45.3
17	20	35.8	30	40.3	29	36.7	28	41.2
18	34	35.8	60	43.9	50	44.4	50	44.4
19	42	45.3	23	27.6	40	48.5	40	31.3
20	26	49.4	26	35.8	25	51.6	26	34.9
21	27	40.8	24	35.2	40	40.8	21	37.1
22	34	34	50	43	54	33	48	43

involved in power grip, massage was used for all the muscles. In addition, a time lag between the massage intervention and postintervention measurement may reduce the effect of massage on performance. However, athletic or nonathletic participants may influence the effectiveness of massage for performance. Muscle performance in athletic participants is near its peak, but nonathletic participants are far from their peak performance. Therefore, massage may cause more positive effects in nonathletic individuals. The mechanism of massage on muscle performance is not completely known, and more studies are needed to investigate the effects of massage on performance.

Because factors such as age, sex, weight, height,[42,43] sports, muscle fatigue, neuromuscular disease, musculoskeletal dysfunctions, anxiety, temperature, warm-up,[44] and physical activity can influence grip performance, in this study, an attempt was made to diminish the confounding effect of these factors as much as possible. All the participants were young and healthy; BMI was between 22 and 25 kg/m^2; all the participants were nonathletic; and during the test, the participants were comfortable and relaxed. They had no anxiety and were encouraged verbally to put in maximum effort. They had no neuromuscular or musculoskeletal dysfunction, and they warmed up for 5 minutes before the test.

Because a lot of activities require proper hand grip strength and endurance, introducing convenient methods to improve hand performance is desirable. The results of this study support the idea of hand and forearm massage to improve grip performance.

Limitations and Future Studies

One of the limitations of this study is that both the measurement and intervention were performed by the same therapist. However, to reduce bias, it would be better that a therapist measured the hand grip strength and endurance, while another performed the intervention. Another limitation of this study is that only the dominant hand in male subjects was tested. It is suggested that, in future studies, both the dominant and nondominant hands in female and male subjects be examined. In addition, the immediate effects of massage on grip performance were investigated in the present study. However, if possible, future studies should examine the long-term effects of massage on grip. Another limitation is that there was no rest group in this study. In addition, all participants in this study were healthy young men from a university population and not the general population. It is suggested that studies with older participants or patients should be performed to provide diverse backgrounds. Finally, measurement of hand grip strength and endurance was found to be greatly dependent on the motivation and cooperation of the subjects. Therefore, the study was designed in such a way that provided verbal encouragement and comfort for the participants.

Conclusion

The present study showed that application of 1 massage session immediately improved hand grip endurance in healthy young men and improved hand grip strength.

Funding Sources and Conflicts Of Interest

No funding sources or conflicts of interest were reported for this study.

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