Effects of 12 Months of Kettlebell Training on an Individual with Myasthenia Gravis

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BACKGROUND

Myasthenia gravis (MG) is an autoimmune disease that affects skeletal muscles and results in impaired acetylcholine receptor function and neuromuscular transmission (1,2). Hallmark symptoms linked to MG include chronic muscle weakness and fatigue coupled with limited physical function and exercise tolerance, collectively making it challenging for patients and clinicians to understand whether regular exercise training is safe and beneficial (2). A more contemporary view is that patients with MG can safely participate in exercise training programs that can lead to improvements in functional and psychological outcomes, although the supporting body of evidence is limited in size, and researchers have yet to exhaustively test the merits of exercise training as a therapeutic intervention for this population (1,3,4). Among the studies in which authors have demonstrated that patients with MG benefit from routine exercise training, none have tested whether free-weight resistance training is beneficial in the long term (i.e., >6 months). Therefore, because long-term resistance training is safe and beneficial among other groups of patients with skeletal muscle and/or autoimmune conditions (5,6), we sought to describe longitudinal changes in functional, physiological, and psychological outcomes in a patient with MG participating in a year-long resistance training program focusing on kettlebell training (KT). We acquired serial strength measurements of both small and large muscle groups and conducted functional tolerance testing as primary outcome metrics. Secondary outcome metrics included serial changes in bone mineral density (BMD), body composition (fat mass (FM) and fat free mass (FFM)), vascular health, resting energy expenditure (REE), life satisfaction, and positive affect.

PROTOCOL OVERVIEW

Voluntary written informed consent was provided by the individual described in this case report prior to participating in study activities. The study protocol was reviewed and approved by the Towson University Institutional Review Board, and all study procedures adhered to those outlined in the Declaration of Helsinki. Continual maintenance of routine medical therapy was required for the duration of study participation.

Participant Background

The study participant was a 72-year-old female diagnosed with MG 8 years prior. Standard pharmacological therapies that were taken regularly over the duration of the year-long study intervention included mycophenolate mofetil (Cellcept®; 500 mg/2× daily (morning and evening) and 250 mg/daily (midday)), pyridostigmine bromide (Mestinon®; 60 mg/4× daily for the first 7 months of the study, and 60 mg/2× daily thereafter), atorvastatin (Lipitor®; 10 mg/daily for the first 5 months of the study, and thereafter 20 mg/daily), duloxetine (Cymbalta®; 60 mg/daily), and calcium carbonate/D3 (600 mg/2× daily). Her self-reported physical activity included daily walking (totaling approximately 410 min/week), but no other form of exercise training occurred prior to enrolling in the present research study.

Physiological, Anatomical, and Psychological Testing

The participant visited our laboratory for baseline testing (1 week prior to initiating the KT program) and then at the end of each training cycle (every 2 months) until completing 12 months of training. All repeat testing was completed at

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least 72 hours after a training session and in the morning, a time of the day in which individuals with MG report feeling stronger (2). The following tests/assessments were conducted during each visit to the laboratory after approximately 8 to 12 hours of fasting: body mass (digital scale (Tanita Corporation, Arlington Heights, Illinois)), height (stadiometer (SECA North America, Chino, California)), body composition and BMD (dual energy x-ray absorptiometry scan (Lunar Prodigy Densitometer, GE Healthcare, Madison, Wisconsin)), vascular health (augmentation index (SphygmoCor XCEL, Atcor Medical, Sydney, Australia)), REE (indirect calorimetry (ParvoMedics, Salt Lake City, Utah)), lower extremity function (stair climb (time to ascend 11 steps)), grip strength (hand held dynamometer (Jamar Hydraulic Hand Dynamometer, Patterson Medical, Warrenville, Illinois)), maximal isometric knee strength (MicroFET2 Wireless dynamometer (Hoggan Scientific LLC, Salt Lake City, Utah)), Short Physical Performance Battery (SPPB) test (gait speed, chair stands, and standing balance), and self-reported life satisfaction and positive affect (NIH Toolbox® Emotion Battery (NIHTB-EB) tool; Version 1.19; www.Healthmeasures.net/nih-toolbox). Although the NIHTB-EB differs from the more commonly used surveys for MG, the NIH Toolbox was used to assess psychological well-being in individuals living with a variety of clinical conditions (7).

Kettlebell Testing and Exercise Training Intervention

Trained personnel from the Baltimore Kettlebell Club in Baltimore, Maryland, conducted a baseline assessment to establish the initial weights for each exercise (i.e., deadlifts, shoulder presses, bent over rows, squats, and swings). Briefly, a kettlebell instructor demonstrated the proper technique for each exercise while allowing the participant to learn the movement with a relatively low weight to ensure correct exercise form was performed. Once the participant became familiar with the technique, the resistance was increased so that she could perform 3 sets of 10 repetitions of each exercise with a target rating of perceived exertion (RPE) of 7/10—this was the target training intensity used throughout the study (some training days included a higher RPE; these were days in which 1 repetition maximum for deadlift and/or maximum number of repetitions for shoulder presses, bent over rows, and squats were performed).

The KT program was prescribed to be performed twice per week (45 min each session) for a total of 12 months of training. Every training session started with a warmup of joint mobility exercises (~5–15 min) followed by get down/get up exercises (~2–3 min). The training progression increased in the number of sets, repetitions, and resistance to induce progressive overload within each training cycle. The 12-month KT program was composed of 3 training cycles: a 2-month deadlift training cycle, a 2-month swing training cycle, and a combined deadlift/swing training cycle for the remainder of the training period. The deadlift training cycle consisted of deadlifts, shoulder presses, bent over rows, and squats. Deadlift training progression primarily focused on gradually increasing total volume through manipulation of sets, repetitions, and resistance while maintaining a target RPE of 7/10. For shoulder press and bent over rows, the participant performed 3 sets of 5 repetitions from week 1 until week 7. At week 8, the participant was encouraged to perform 1 set of as many repetitions as possible using the same resistance used during training. Lastly, the participant performed 1 set of 10 squats with body weight only during weeks 1 and 2, then increased the number of sets and resistance during weeks 3 through 7. Week 8 included 1 set of as many repetitions as possible of weighted squats. After completing the first 2 months, kettlebell swings were introduced to the participant's training program. The progression for the swing training primarily focused on increasing the number of sets of 10 repetitions each week. Deadlifts were also performed at weeks 4 and 8 during the training program with kettlebell swings (no kettlebell swings were performed during weeks 4 or 8). Shoulder press, bent over row, and squat exercises followed the same progression of sets and repetitions as they did within the deadlift cycle. After completing 2 months of the swing training cycle, the participant performed a combined training of alternating deadlifts and swings between different days of the week while also performing shoulder presses, bent over rows, and squats. Ample rest was given between main sets to provide adequate recovery.

RESULTS

The participant completed 66% of training sessions scheduled over the year-long intervention. Overall, grip strength and knee extension torque increased after 12 months of training (+25.7% and +14.9%, respectively; Table 1). Time to ascend stairs decreased 37%, and SPPB score increased from 7 (moderate physical function) to 10 total points (high physical function) after 12 months of training (Table 1).

Body weight increased over the duration of the intervention, primarily due to increased FFM (from 106.3 to 109.9 lb (48.3 to 50 kg); Table 2). This was consistent with REE increasing approximately 4% (from 1,409 to 1,466 $Kcal{\cdot}d^{-1}$) over the year-long intervention. However, the training period resulting in the largest increase in FFM was from baseline to 4 months of training (5.5 lb (2.5 kg)). No changes occurred in BMD, and a small increase in FM (1.3 lbs (0.6 kg)) was observed.

In addition to improvements in muscle function and FFM, vascular health also improved after 12 months of KT (Table 3). Both brachial and aortic systolic pressure (−10.6% and −9.8%, respectively) decreased preintervention to postintervention. Similarly, augmentation index (AIx%; −21.4%) and augmentation index normalized to 75 $b{\cdot}min^{-1}$ heart rate (AIx75%; −27.5%) both decreased preintervention to postintervention.

Lastly, the 12-month general life satisfaction and positive affect scores also improved over those recorded at baseline (from the 47th to the 53rd percentile and from the 49th to the 51st percentile, respectively).

TABLE 1. Summary of changes in grip strength, knee extension torque, time to ascend stairs, and Short Physical Performance Battery (SPPB) test total score and classification.

	Muscle Strength and Function				
	Grip Strength (kg)	Knee Extension Torque (n·M)	Time to Ascend Stairs (s)	SPPB—Total Score	SPPB—Classification
Baseline	24.5	73.0	8.8	7	Moderate physical function
2 mo	21.0	63.4	8.1	7	
4 mo	25.0	91.8	8.0	9	
6 mo	30.0	97.2	6.8	8	
8 mo	30.0	93.3	6.0	8	
10 mo	30.0	97.5	6.2	10	High physical function
12 mo	33.0	93.0	5.5	10	

TABLE 2. Summary of changes in body weight, body mass index (BMI), percentage (%) body fat, bone mineral density (BMD), fat mass, fat free mass, and lean mass from baseline until 12 months of training.

	Body Composition						
	Body Weight (lb)[a]	BMI ($kg·m^{-2}$)[b]	% Body Fat[b]	BMD ($g·cm^{-2}$)[b]	Fat Mass (lb)[b]	Fat Free Mass (lb)[b]	Lean Mass (lb)[b]
Baseline	200.6	33.4	47.5	1.1	92.0	106.3	101.5
2 mo	202.6	33.7	46.7	1.1	91.0	108.7	104.0
4 mo	209.0	34.8	47.0	1.1	94.7	111.8	106.9
6 mo	202.2	33.6	47.6	1.1	92.7	107.1	102.2
8 mo	200.0	33.3	46.9	1.1	92.3	107.0	102.1
10 mo	203.6	33.9	48.0	1.1	93.8	106.6	101.6
12 mo	203.6	34.0	47.1	1.1	93.3	109.8	104.9

[a]Results derived from digital scale.
[b]Results derived from dual energy x-ray absorptiometry.

TABLE 3. Longitudinal changes in parameters related to vascular health throughout the study: brachial systolic blood pressure (SBP)/diastolic blood pressure (DBP), aortic SBP/DPB, aortic pulse pressure, aortic augmented pressure, augmentation index (AIx%), augmentation index normalized to 75 $b·min^{-1}$ heart rate (AIx75%), and mean arterial pressure.

	Vascular Function					
	Brachial SBP/DBP (mmHg)	Aortic SBP/DBP (mmHg)	Aortic Pulse Pressure (mmHg)	Aortic Augmented Pressure (mmHg)	AIx%/AIx75%	Mean Arterial Pressure (mmHg)
Baseline	141/86	132/87	45	19	42/40	104
2 mo	134/71	123/73	50	21	43/40	92
4 mo	123/76	115/78	37	15	39/35	91
6 mo	128/65	119/67	52	22	43/37	86
8 mo	130/61	120/63	57	24	42/36	84
10 mo	124/74	115/74	41	16	39/38	91
12 mo	126/84	119/85	34	11	33/29	97

DISCUSSION

Overall, the results of our case study highlighted that 12 months of KT was safe and yielded beneficial effects on measures of muscle function, physiological function, and psychological well-being in an individual with MG. To our knowledge, this is the first report describing the multidimensional longitudinal effects of KT-based resistance training on functional, physiological, and psychological measures in an individual with MG. Additionally, we are the first group to evaluate serial changes in vascular health and REE (i.e., metabolic function) in a patient with MG in response to resistance training.

A limited number of studies exist in which authors have evaluated changes in muscle strength in response to resistance training in patients with MG (3,6,8). Chang et al. (6) evaluated the effects of 24 weeks of aerobic and resistance training in patients with MG and observed an average increase of 8% in hand grip strength. In comparison, the present study participant demonstrated a 22% increase in hand grip strength after 24 weeks of KT, which is a difference that could be attributed to evaluating only body weight exercises without involving exercises focused on the upper body. Lohi et al. (8) separately reported that knee extension torque increased 23% after 10 weeks of resistance training, whereas others (3) report smaller-sized improvements of 9% in maximal isometric voluntary knee extension following 8 weeks of progressive resistance training. The improvements in knee extension torque noted for our participant are consistent with those of Lohi et al. (8), whereas we show further accompanying improvements in functional outcomes (stair climb and SPPB). These coexisting improvements have clinical and real-world relevance since knee extensor muscle strength is reported to be reduced by ~28% in patients with MG compared with healthy controls (9).

Some limitations of the current case report include that diet and physical activity (outside of the training days) were not monitored. Additionally, another limitation was that the MG classification for the participant was not provided. Lastly, as expressed by others (10), seasonal variation can have an effect in individuals with MG, as temperature and environmental factors may lead to more sedentary behaviors due to disease symptoms. This is confirmed in the attendance report from our participant—while she attended ~71% of training sessions for the first 6 months of training (from April until September), her attendance decreased to ~61% during the last 6 months of the study (from October until March).

Exercise training is proposed as a safe and nonpharmacological approach to attenuate disability and symptoms in different neurological and neuromuscular diseases without serious adverse events (5). While resistance training is an effective method to attenuate loss of muscle mass and strength, patients with MG are encouraged to avoid or restrict routine physical exercise to prevent overusing already weak muscles (6,11). By contrast, the present case study and other more contemporary studies suggest that exercise training can be safe and tolerable for individuals with MG (3,6,8). Accordingly, due to differences in medical history, symptoms, and physical abilities among individuals with MG, exercise training programs should always be prescribed based on individual needs and capabilities (1). Future randomized studies should be designed to fully determine exercise training recommendations/guidelines (frequency, time, type, and intensity) for individuals with MG.

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