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Technical Note

Early-Phase Strength Gains During Traditional Resistance Training Compared With an Upper-Body Air-Resistance Training Device

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[1]*Department of Physical Education and Sport Sciences, University of Limerick, Limerick, Ireland;* [2]*Department of Health Physical Education & Recreation, Northern Michigan University, Marquette, Michigan 49855;* [3]*Bio-Medical Research Ltd., Parkmore Business Park West, Galway, Ireland.*

Abstract. McGinley, C., R.L. Jensen, C.A. Byrne, and A. Shafat. Early-phase strength gains during traditional resistance training compared with an upper-body air-resistance training device. *J. Strength Cond. Res. 21(2):621–627. 2007.*—The purpose of this study was to examine the early-phase adaptations of traditional dynamic constant external resistance (DCER) training vs. a portable upper-body training device (Fortex). The Fortex is a concentric training device based on air resistance. Contractions using this device are slow (1.5–3 s) and have a limited range of motion. The exercises potentially allow maximal muscle action during each contraction. Healthy, sedentary men ($n = 30$) were assigned to begin either 8 weeks of weight training (W, $n = 12$) or 8 weeks of Fortex training (F, $n = 9$), and were compared with a control group (C, $n = 9$). Exercises were chosen for the W group that would train similar muscle groups and contain a similar volume of repetitions as the F group. However, movement patterns and force curves were not identical. Increases in the upper-arm cross-sectional area were not detected in any of the groups. Both training groups showed strength gains in the various strength tests that were distinct from each other. Our results indicate that both Fortex and DCER training proved effective in eliciting strength gains in sedentary men over an 8-week training period. There are, however, limitations with the Fortex in terms of progression needs and training asymmetry that indicate it should be used as a complement to other training.

Key Words. Fortex, isokinetic, isometric, repetition maximum, weights, muscle

Introduction

It has been demonstrated many times that skeletal muscle can be trained by a variety of methods, with resultant increases in muscle size (cross-sectional area) and muscle force production (3, 18). Conventional resistance training programs using load-bearing exercises, such as machine weights and free weights (dynamic constant external resistance [DCER] training), are known to increase strength early in training. Most of the strength increases for untrained individuals occurs during the early phase (first 4–8 weeks) of resistance training (2, 23).

Traditional machine-based weight training overloads the muscle at the acceleration phase of contraction and the last repetitions of a set. To optimize strength gains, it is necessary that sets be performed that include maximal voluntary muscle actions, i.e., that the exercise is performed until concentric failure is achieved (10). Exercises can be performed over a large range of motion (ROM), depending of course on the joint involved and the body position. It is generally assumed that training over a full ROM will allow for strength gains over that range. Evidence for this is primarily provided by studies using isometric training, whereby improvements in strength were found to be specific to the angle at which training occurred, albeit with carryover to other joint angles, particularly when training was at longer muscle lengths (17, 25). It appears therefore that to gain the maximum benefit from training, exercises must be conducted over the greatest, comfortably achievable ROM (11). This is a distinct advantage of training with machine (or free) weights because exercises can be performed over the maximum ROM.

The Fortex (Bio-Medical Research Ltd., Galway, Ireland) is a training device for the upper body based on air resistance (Figure 1). The Fortex uses air pressure to elicit an overload in 2 distinct forms: resistance generated by compressed air and resistance generated by a vacuum. A single contraction on the Fortex consists of a slow (1.5–3 s) maximal contraction with only a small change in joint angle (measured at between 5 and 30° depending on the exercise). The exercises are concentric in nature and allow for maximal muscle action in each contraction, thereby giving the potential for maximal motor unit activation. This theoretically offers muscle overload each time, potentially optimizing training intensity.

The DCER training normally involves alternating concentric and eccentric actions. This is an important factor because it has been found previously that exercises that include an eccentric action elicit greater strength gains than concentric-only exercises (8). Dudley et al. proposed that this was primarily due to training intensity not being optimal when eccentric actions are excluded. The authors argue that maximal eccentric actions enhance the neural adaptations due to resistance training. Eccentric actions uniquely recruit motor units in reverse order, compared with concentric or isometric actions, for example, with faster twitch motor units being recruited first (9). The inclusion of an eccentric action in resistance training therefore allows for recruitment of these fast twitch motor units, which otherwise would not be maximally activated, particularly in untrained individuals. Furthermore, eccentric actions have been found to induce greater hypertrophy in type I and type II fibers than a similar volume of concentric actions (15).

The purpose of this study was to compare strength gains and muscle hypertrophy between a slow variable resistance training device and DCER training.

Figure 1. Image of the Fortex training device.

Table 2. Descriptive characteristics of subjects, mean (SD).

Variables	Weights group (n = 12)	Fortex group (n = 9)	Control group (n = 9)
Age (y)	26.9 (4.8)	26.8 (5.4)	25.2 (4.4)
Height (cm)	180.7 (6.7)	181.0 (5.6)	180.1 (7.1)
Weight (kg)	82.1 (13.3)	79.9 (15.2)	78.7 (8.5)

Methods

Experimental Approach to the Problem

Volunteers were put into 2 training groups and a control group. One group trained exclusively on the Fortex (F), the other group trained on machine weights (DCER, W), and the control group (C) did not train. Resistance programs were chosen that would work similar muscle groups and that would contain a similar volume of repetitions per week (Table 1). The goal of the study was to compare the efficacy of 2 distinct training methods and not to compare similar movement patterns or force curves (see Training Programs below). Furthermore, muscle volumes were measured to establish whether hypertrophy underlies any potential strength gains.

Subjects

Thirty healthy men (mean [*SD*] age = 26.4 [4.8] years, height = 180.6 [6.3] cm, weight = 80.4 [12.4] kg) were assigned to 3 groups: weights (W), Fortex (F), and nontraining control (C). Groups were randomly allocated to each treatment. The characteristics of each group are shown in Table 2. To prevent training status differences between groups from affecting the outcome, the groups were matched for mean scores for height, weight, age, Fortex strength, and isokinetic strength. Pretest differences between the groups were found to be nonsignificant ($p > 0.05$) for each of these parameters.

All subjects were informed of the procedures and risks and signed an informed consent document. All procedures were approved by the University of Limerick Research Ethics Committee. Although physically active, all subjects were considered untrained and had not participated in any upper-body resistance training during the 6 months before the study. Each participant was instructed to continue his normal activities for the duration of the study.

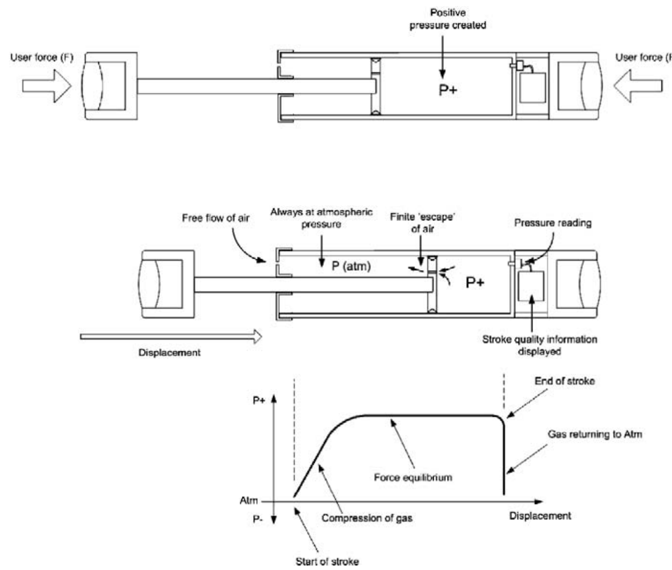

Figure 2. Fortex pressure change providing resistance during elbow flexion exercises.

Fortex

The resistive element in the Fortex is provided by a piston and a cylinder with a small orifice that allows air to be expelled from or taken into the cylinder. As the user applies force to the piston by elbow flexion, air is forced out through the orifice and the resistance to airflow through the orifice results in an increase in pressure in the cylinder (Figure 2). The resistive force to inward movement of the piston is approximately equal to the cylinder pressure times the area of the piston, and this resistive force is always less than the applied force because of the leak of air though the orifice. The rate of movement of the piston with time depends on the magnitude of the applied force, which is opposed by the pressure of the air

Table 1. Volume of training performed per week during the course of the 8-week study.

Group*	Exercise	Sets†	Reps‡	Sessions§	Load	Exercise reps§	Total reps§
W	Chest press	2	8–12	2	60–70% 1RM	32–48	
W	Shoulder press	2	8–12	2	60–70% 1RM	32–48	
W	Seated row	2	8–12	2	60–70% 1RM	32–48	160–240
W	Biceps curl	2	8–12	2	60–70% 1RM	32–48	
W	Triceps pushdown	2	8–12	2	60–70% 1RM	32–48	
F	Chest push	1	10	4	Max effort	40	
F	Overhead push	1	10	4	Max effort	40	160
F	Reverse push	1	10	4	Max effort	40	
F	Reverse pull	1	10	4	Max effort	40	
C				No training			

* W = weights group, F = Fortex group, C = control group.
† per day.
‡ per set.
§ per week.

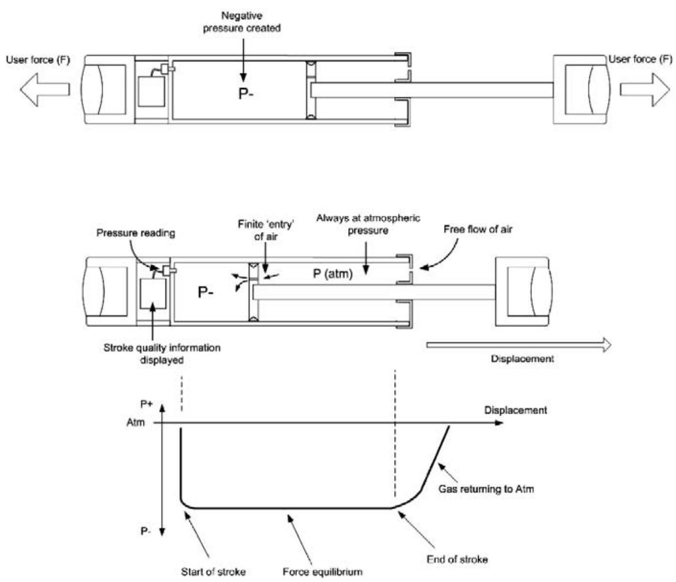

FIGURE 3. Fortex pressure change providing resistance during elbow extension exercises.

acting on the piston face, in addition to frictional forces. A constant applied force throughout the exercise stroke results in a constant velocity of the piston, after the initial pressurization phase. The Fortex may also operate in such a way as to resist withdrawal of the piston from the cylinder, i.e., during elbow extension, by restricting airflow into the cylinder through the same orifice (Figure 3).

The Fortex is rated to withstand forces up to 500 N, although the maximum force measurable by the Fortex pressure sensor is approximately 380 N. This upper limit corresponds to approximately 1,000 Fortex units. It should be noted here that the maximum score achieved by any of the subjects in the current study was 434 Fortex units, i.e., approximately 217 N.

Procedures

Subjects were familiarized with all procedures prior to testing. Care was taken to ensure that the same testing methodology was used for all groups.

Anthropometric Measurements. During the pretest (WK0), each subject's weight (in kg) was measured using an electronic scale to the nearest 0.01 kg, and height (in cm) was measured on a standard medical stadiometer. Upper-arm length and circumference were measured at 3 locations (14), and skinfold measurements of the biceps and triceps were taken using a skinfold calipers (Harpenden, British Indicators, West Sussex, UK) (13). From this data upper-arm muscle circumference was calculated. Upper-arm volume was calculated using the frustum formula as reported by Karges et al. (16), and upper-arm muscle cross-sectional area was calculated from the formula reported by Maud and Foster (19).

Fortex Tests. Subjects completed a standardized warm-up of static stretches for the triceps, deltoids, pectorals, trapezius, and biceps. Each participant then performed 3 trials on the Fortex reverse push at 50% of their perceived maximal effort. Instruction was given as to correct technique (Figure 4a); the subjects were then told to apply maximum force for 3 trials, with 60-second rest between trials. The same procedure was followed for the overhead push (Figure 4b). The maximum score was recorded for each test from a digital readout. Maximum contractions were confirmed by less than 5% difference between efforts.

Isokinetic Strength Test. Subjects were then tested using a Biodex isokinetic dynamometer (Biodex System 2; Biodex Medical Systems, Shirley, NY). Previous research has shown the Biodex dynamometer to be an accurate and valid test tool (24). Lever arm ROM was constrained to occur between 170 and 45° elbow extension, and the lever arm length was maintained at a constant length per subject in accordance with Perrin (21). Prior to testing, the subjects completed 3 continuous warm-up movements at 0.52 $rad \cdot s^{-1}$ at approximately 50% of their perceived effort. Isokinetic peak torque was determined for the biceps during concentric elbow flexion and for the triceps during concentric elbow extension at 0.52 $rad \cdot s^{-1}$. This angular velocity was chosen because training using both the Fortex and machine weights involves a slow contraction speed. Wrigley and Strauss (26) have previously recommended selecting a test movement velocity similar to the sport or exercise movement velocity being tested. For each contraction the subjects were verbally encouraged to apply maximum force from the start and maintain it throughout. There was a 5-second rest in between the biceps flexion and triceps extension to negate any possible influence of the stretch-shortening cycle. There was a minimum of 3 trials, with a value for isokinetic peak torque accepted if at least 2 of the trials differed by less than 5%. The maximum torque achieved for each test was recorded.

Isometric Strength Test. For the isometric tests, the Biodex lever arm was set at 135° elbow extension. After a 2-minute rest from completion of the isokinetic trial, subjects performed a minimum of 3 trials for isometric torque of the biceps and isometric torque of the triceps. Subjects were instructed to apply maximum force from the start and maintain it for a 5-second contraction for

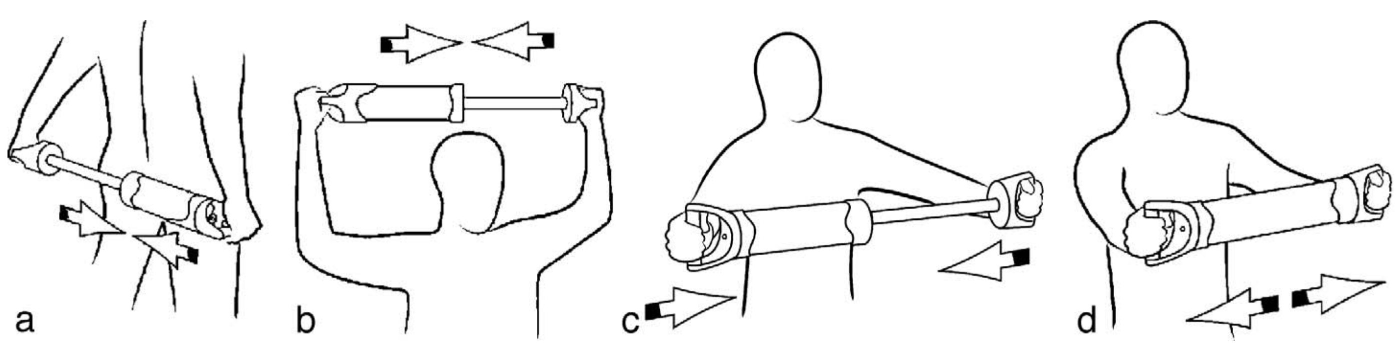

FIGURE 4. Arrows indicate the direction in which force is applied. (a) Fortex reverse push exercise. (b) Fortex overhead push exercise. (c) Fortex chest push exercise. (d) Fortex chest pull exercise.

the biceps followed by a 5-second rest and a maximum isometric force for the triceps for a 5-second contraction. Simple, consistent, verbal encouragement was given throughout. A minimum of 3 trials were conducted with a 60-second rest between each repetition, with a value for isometric peak torque accepted if at least 2 of the trials differed by less then 5%. The maximum score achieved for each test was recorded.

DCER: Three Repetition Maximum Test. A pretest for 3 repetition maximum (3RM) testing was conducted on a separate day to the other strength tests. The 3RM was defined as the maximum weight a subject could lift for just 3 repetitions. A standardized warm-up was completed prior to any testing, with each participant exercising for 3 minutes on a rowing ergometer, followed by joint rotations and 5 static stretches for the upper body described above. Subjects were instructed as to correct technique on 5 different exercises (seated chest press, shoulder press, seated cable row, biceps curl, and triceps pushdown) using machine weights (Paramount Fitness Corp., Los Angeles, CA). These machines were selected to train the same upper-body muscles as the Fortex device. The test protocol used has been previously reported (19).

One subject suffered an unrelated wrist injury and was excluded from the biceps curl. Hence, there were 8 individuals available for the biceps curl for the Fortex training group.

Training Programs

The training subjects participated in an 8-week training program for the upper body. It was not possible to match training volumes exactly in terms of absolute load because the load using the Fortex is dictated by the user rather than an external load. The W group trained 2 days per week under full supervision on 5 exercises using the 3RM tests: seated chest press, shoulder press, seated cable row, biceps curl, and triceps pushdown. The primary agonists that these exercises train respectively are the pectoralis major, anterior and medial deltoids, latissimus dorsi and muscles of the upper back (rhomboids, trapezius and teres major), biceps brachii, and triceps (4). All training was fully supervised by the tester. After performing the standardized warm-up described above, training was performed at 60 to 70% of predicted 1RM (calculated from 3RM, Baechle and Earle) and subjects performed 8 to 12 reps for 2 sets of each exercise. Multijoint exercises were performed first, followed by the 2 single-joint exercises, with "push" and "pull" exercises alternated. There was a 2- to 3-minute rest period between sets for the 3 multijoint exercises, and a 1- to 2-minute rest period between sets for the 2 single-joint exercises. There was a 2-minute rest between exercises. The resistance was progressively increased using the "2-for-2" rule (4). Hence, if the subject could perform 14 repetitions in the second set in 2 consecutive workouts for a certain exercise, then the weight was increased for that exercise for the next training session.

The F training group trained 4 days per week on the 4 exercises: chest push, overhead push, reverse push, and chest pull (Figure 4). From qualitative assessment the primary muscles trained by these exercises are the pectoralis major, biceps brachii and deltoids, triceps, rhomboids, and trapezius, respectively. Two training sessions were supervised by the tester, and 2 training sessions were performed independently. The training followed the programmed protocol outlined for strength training in the Fortex manual. After performing a warm-up, subjects completed 1 set of 10 continuous repetitions for each exercise, having been instructed to apply their maximum force each time. One set of each exercise was completed in the exercise order noted above. There were rest periods of up to 2 seconds between repetitions and rest periods of 10 to 20 seconds between exercises, with 1 training session taking approximately 10 minutes in total.

The C group was instructed to maintain their normal daily activities and informed not to commence any upper-body resistance training or exercise that might induce training adaptations in the muscles of the upper body.

Post-Tests

Post-tests were identical to pretests and conducted after 4 weeks of training (WK4) and after 8 weeks of training (WK8). All post-test measurements were made with the tester blinded to the pretraining values. Each subject performed their post-tests at the same time of day as the pretest. There was no training in the 24 hours preceding testing.

Statistical Analyses

Descriptive statistics were used to derive means and standard deviations (*SD*) for all variables, and data are presented in the form mean (*SD*). Statistical analyses for isometric torque, isokinetic torque, 3RM, Fortex readings, and anthropometric measures were calculated using repeated measures analysis of variance (RM-ANOVA) using SPSS Version 11.0 (SPSS, Inc., Chicago, IL). Posthoc analysis was performed by examining the means and confidence intervals. Differences were considered significant at $p \leq 0.05$. Partial eta squared (η_p^2) was calculated for effect sizes.

Results

Intraclass correlation coefficients (ICCs) were calculated as above 0.8 on all parameters tested, apart from Fortex reverse push (0.73), triceps isometric peak torque (0.67), biceps curl 3RM (0.7), and chest push 3RM (0.79).

All groups increased in upper-arm muscle circumference, although these did not reach statistical significance. At WK0 values ranged from 26.4 ± 2.2 cm to 27.9 ± 1.5 cm, and groups increased between 1.0 ± 2.0% and 4.5 ± 5.3% after 8 weeks. Upper-arm muscle cross-sectional area ranged between 55.8 ± 9.3 cm^2 and 62.3 ± 6.5 cm^2 at WK0 and increased between 2.1 ± 4.0% and 9.5 ± 11.2% by WK8. The increase for F was statistically significant after 4 weeks of training ($p < 0.05$). However, this increase may be spurious because differences were not significant after 8 weeks of training. Upper-arm volume increased in the 3 groups by between 3.1 ± 3.1% and 5.5 ± 4.3% at WK8, from a range at WK0 of 2473 ± 531 cm^3 and 2602 ± 425 cm^3 (not statistically significant).

Muscle performance for the 3 groups pre- and post-test is shown in Tables 3 and 4. The control group did not change significantly between WK0 and WK8 in any of the strength tests, apart from the seated row 3RM. The F group showed greatest increases in Fortex strength measures, while W showed greatest increases in 3RM tests. For any data that were found to be significantly different at WK0, the percentage differences were calculated taking pretest as 100% baseline, and repeated measures ANOVA were calculated on the percentage data (Table 5).

Discussion

The present study has shown that training with the Fortex causes significant increases in Fortex test measures

TABLE 3. Mean (*SD*) values for Fortex tests, isokinetic tests, and isometric tests for the 3 groups during the course of the 8-week study.

Variable	Group*	WK0	WK4	WK8	η_p^2
Fortex reverse push (Fortex units)	W	170.3 (33.4)	184.6 (42.8)	197.3 (43.5)‡	
	F	171.0 (28.2)	206.2 (36.2)§	226.4 (41.7)§	0.246
	C	155.9 (19.1)	152.6 (32.9)	157.2 (26.0)	
Fortex overhead push (Fortex units)	W	251.7 (37.3)	267.5 (46.0)	285.5 (43.3)†	
	F	242.4 (47.0)	306.8 (48.5)§	338.2 (59.5)§	0.135
	C	247.0 (46.9)	247.4 (51.4)	250.0 (51.8)	
Biceps isokinetic peak torque (Nm)	W	50.1 (9.1)	49.3 (10.2)	54.4 (8.4)	
	F	50.8 (12.0)	56.1 (14.5)	58.8 (13.1)†	0.02
	C	50.6 (13.3)	52.1 (12.2)	52.1 (10.0)	
Triceps isokinetic peak torque (Nm)	W	43.9 (11.2)	43.9 (9.6)	47.9 (12.6)	
	F	50.7 (12.0)	51.9 (12.8)	52.7 (12.2)	
	C	48.0 (10.0)	48.6 (10.9)	49.2 (10.7)	
Biceps isometric peak torque (Nm)	W	52.5 (8.7)	54.3 (9.5)	58.4 (8.2)	
	F	53.8 (13.3)	59.8 (16.2)	60.5 (16.3)	
	C	53.9 (12.2)	55.5 (11.7)	56.0 (10.5)	
Triceps isometric peak torque (Nm)	W	50.9 (10.2)‖	56.8 (9.3)	56.6 (9.4)	
	F	56.3 (13.9)	62.2 (14.2)	56.6 (10.5)	
	C	60.9 (15.9)	59.1 (16.3)	57.0 (15.9)	

* W = weights, F = Fortex, C = control.
† Significant change from pretest data ($p < 0.05$).
‡ $p < 0.01$.
§ $p < 0.001$.
‖ Significantly different from control at pretest ($p < 0.05$); refer to Table 5.

TABLE 4. Mean (*SD*) values for 3 repetitions maximum (3RM) tests for the 3 groups during the course of the 8-week study.*

Variable	Group	WK0	WK4	WK8	η_p^2
Chest press 3RM (kg)	W	60.1 (7.6)	65.4 (5.5)	68.6 (5.4)‡	
	F	71.1 (15.9)	72.6 (14.4)	73.3 (13.8)	0.125
	C	65.8 (5.9)	65.5 (7.1)	66.5 (6.3)	
Shoulder press 3RM (kg)	W	37.6 (8.8)‖	44.8 (7.9)	47.1 (7.7)	
	F	45.4 (9.6)	44.6 (5.3)	49.1 (8.4)	
	C	46.1 (4.1)	44.6 (5.3)	46.1 (6.3)	
Seated row 3RM (kg)	W	55.2 (7.7)	57.1 (6.3)	59.0 (7.0)	
	F	60.5 (8.8)‖	62.0 (8.5)	61.0 (10.4)	
	C	53.9 (9.2)	56.4 (8.8)	57.0 (6.8)	
Biceps curl 3RM (kg)	W	18.9 (3.1)	21.9 (3.4)†	23.2 (2.8)§	
	F	20.7 (3.9)	21.3 (3.2)	23.2 (4.0)†	0.077
	C	19.7 (3.6)	19.9 (1.9)	19.9 (2.2)	
Triceps pushdown 3RM (kg)	W	19.1 (2.3)	21.5 (2.5)‡	23.4 (3.7)§	
	F	20.7 (4.0)	21.2 (3.8)	22.2 (4.1)	0.046
	C	19.7 (2.0)	19.9 (2.2)	20.4 (2.0)	

* W = weights, F = Fortex, C = control; 3RM = 3 repetition maximum.
† significant change from pretest data ($p < 0.05$).
‡ $p < 0.01$.
§ $p < 0.001$.
‖ Significantly different from control at pretest ($p < 0.05$); refer to Table 5.

TABLE 5. Mean (SD) percentage differences for variables differing at pretest (WK0) for the 3 groups during the course of the 8-week study.

Variable	Group*	WK0	WK4	WK8	η_p^2
Triceps isometric peak torque	W	100	113.0 (11.9)†	112.6 (15.1)†	
	F	100	112.3 (16.6)†	108.6 (20.9)	0.04
	C	100	97.7 (15.1)	94.5 (13.6)	
Shoulder press 3RM	W	100	121.6 (17.7)‡	128.4 (24.0)‡	
	F	100	101.3 (19.7)	110.9 (23.3)	0.092
	C	100	96.7 (6.6)	99.8 (7.0)	
Seated row 3RM	W	100	104.3 (11.4)	107.6 (10.9)†	
	F	100	102.8 (5.5)	100.5 (5.0)	
	C	100	104.1 (9.5)	106.8 (11.1)†	

Analysis of percentage differences was performed only on data that were significantly different at WK0; raw data for these 3 measures are in Tables 3 and 4.
* W = weights, F = Fortex, C = control, 3RM = 3 repetitions maximum.
† Significant change from pretest data ($p < 0.05$).
‡ $p < 0.001$.

after 4 and 8 weeks training, while weight training produced significant increases in Fortex test measures only after 8 weeks training. Both training groups showed different carryover in strength gains to independent test measures. Because the exact nature of contractions using the Fortex is mixed, it is difficult to ascertain how much of the improvements in the various test protocols (isometric, isokinetic, DCER) are attributable to the similarity of the training and how much is an actual carryover in training. The mechanisms that underlie changes in dynamic performance are different from those that underlie changes in isometric strength (5). However, different muscle tests are helpful in determining the carryover effects and relationships of isometric, dynamic, and isokinetic muscle actions to each other (19).

The failure of either resistance training program to elicit significant increases in muscle size seems inconsistent with the majority of similar studies to date. Anthropometric measurements may not be sufficiently sensitive to monitor changes in regional muscle mass over a short time. However, nonsignificant increases in muscle fiber cross-sectional area have been found previously (23), suggesting the positive gains may have reached significance given further duration of training. Evidence of hypertrophy has certainly been shown many times with DCER training. The fact that training with the Fortex does not contain an eccentric action, however, may very well limit the extent of the increase in muscle cross-sectional area (8, 15). As stated in the introduction, a possible reason for this is that eccentric actions preferentially recruit fast twitch muscle fibers (9). Studies of similar duration to the present study have demonstrated selective fast twitch fiber hypertrophy or increases in the ratio between fast twitch and slow twitch fiber area (3). Although the Fortex allows for maximal muscle action during each contraction, it remains to be seen whether users can activate their type II fibers and thereby maximize the potential for hypertrophy. This may be particularly relevant during the early phase of training when sedentary subjects experience neuromuscular inhibition (1, 20). Because the Fortex is a new training device, studies with a longer duration are required to determine its ability to cause hypertrophy.

Numerous studies have demonstrated that increases in strength occur before hypertrophy is apparent in training (2, 7, 20, 27). Most studies have attributed these strength gains to neuromuscular adaptations within the muscle (12, 20). The strength gains achieved by the Fortex group may therefore be attributable to neuromuscular adaptations alone. It has been suggested previously that increases in strength can be induced by any resistance training method, provided that sufficient force is developed (8). It remains to be seen whether further developments in strength can be elicited by training with the Fortex or whether a plateau in strength will be reached.

An important factor in achieving optimal strength gains in any resistance training program is manipulation of the volume and intensity of training, i.e., periodization. With regards to the present study, it was not necessary to introduce periodization due to the short nature of the training protocols (6). Nevertheless, it is an important consideration in terms of the use of the Fortex as a training device over a prolonged period. By varying program variables, such as resistance, number of sets, number of repetitions, and intensity, it is possible to maximize strength gains with traditional DCER training (10). Contractions using the Fortex allow for maximal muscle action each time. This requires that the user apply maximum force during each repetition. Although this may provide an optimal training intensity initially, it does limit the user in terms of progression, because it is not possible to vary the resistance or the intensity unless of course the user trains submaximally. Training at an intensity less than maximal will vary the training but may concomitantly limit the adaptations to training. The Fortex is further limited in its ability to address progression needs apart from periodization. Although it is possible to vary the repetitions, sets, and rest periods, for example, it is not possible to vary the repetition speed beyond a limited range (1.5–3 s), or to vary the ROM. Therefore, it is quite limited in terms of training specificity with regards to contraction velocity, as well as limiting strength gains to angles at or near the exercise ROM (11, 22, 25).

Finally, it must be emphasized that although the Fortex has indeed proved effective in eliciting strength gains in novice resistance training subjects, it is an upper-body–only device; to avoid asymmetrical training, therefore, it must be used in conjunction with training programs for the core and legs.

In summary, the Fortex has proved to be effective in eliciting strength gains in sedentary subjects after 8 weeks of training. These gains have been specific to the Fortex, as well as there being some carryover to dynamic and isometric strength tests. The limitations of the Fortex have been outlined in terms of the progression needs of the user. We have not detected hypertrophy with this device or DCER over the course of an 8-week study. DCER training has consistently been shown to cause hypertrophy, whereas a longer duration study is required to determine if the Fortex can indeed facilitate increase in muscle cross-sectional area or whether strength gains will plateau after a period.

Practical Applications

The results of this study show that air-based resistance training using the Fortex causes increases in muscle strength in sedentary men.

Training twice weekly on machine weights for the upper body has been demonstrated to be effective at eliciting strength increases in sedentary men. Performing 2 sets of 5 exercises at 60 to 70% of predicted 1RM is effective as an initial training intensity.

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