



NUTRITION AND EXERCISE CONSULTING

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In house report: Electromyographic and metabolic analysis of the ABLITERATOR™ exercise device.

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Abstract:

Two healthy male subjects participated in selected abdominal training exercises both on the floor and on the ABLITERATOR™ exercise device while being measured for muscle activation. In addition, one subject underwent twenty minutes of cardiovascular training exercise on the ABLITERATOR™ while being measured for gas exchange and caloric utilization. Based on the electromyographic (EMG) results, the ABLITERATOR™ exhibited mean EMG values comparable to those when performing traditional abdominal exercises on the floor. The pilot data support the efficacy of the ABLITERATOR™ as a portable, upright abdominal training device. Using open-circuit measures to determine energy expenditure the subject burned an average of 594 kcal/hr and achieved a peak caloric expenditure of 778 kcal/hr at a maximal heart rate of 166 bpm. This expenditure is above the guidelines for daily energy expenditure necessary for cardiovascular conditioning, weight loss, health, and disease prevention. Based on the American College of Sports Medicine, and other scientific and medical organizations' guidelines, the values obtained during the ABLITERATOR™ cardiovascular workout represent an intensity range of moderate-to-high intensity.

Introduction:

Over the past decade, use of portable abdominal exercise devices has continued to grow in the infomercial and home markets. Much of the published scientific research fails to support their efficacy as being more effective than a traditional crunch and many have proven to be less effective than traditional abdominal exercises. Of those developed as upright abdominal training devices only two were as effective as a crunch and both never came to the marketplace. The ABLITERATOR™ exercise device was designed as a portable, upright abdominal training device claiming to be as effective as traditional abdominal exercises performed on the floor. Resistance training exercises are designed to overload specific muscle parts or specific muscle groups in order to increase muscular strength and/or endurance. One of the greatest challenges trainers, therapists and physicians face is selection of appropriate exercises and variations in equipment to best isolate a targeted muscle or muscular region. Typically "experts" rely on anecdotal information to determine exercise technique. A more precise determination and quantification of exercise effectiveness can be made, however, with the use of electromyographical (EMG) analysis.

The initial part of this study was performed to examine and compare the timing and

recruitment patterns of the superficial core stabilizers: the upper and lower portions of the rectus abdominis, the external oblique, the erector spinae, and hip flexors during selected ABLITERATOR™ exercise movements and traditional abdominal exercises. The data help to elaborate differences between muscle recruitment when performing each exercise with and without the ABLITERATOR™. Selected electromyographical recordings were analyzed for each exercise movement through the entire duration of each set performed.

Cardiovascular training workouts are designed to overload specific muscles and systems of the body in order to increase heart rate, increase caloric expenditure, and improve endurance. Both the American College of Sports Medicine (ACSM) and the American Council on Exercise (ACE) recommend cardiovascular workouts as necessary components of any effective weight loss and weight management program. In addition, cardiovascular exercise has been recommended by the medical community to prevent and treat diabetes, heart disease, and other degenerative diseases. One of the greatest challenges the public faces is the selection of appropriate workouts to best meet these goals and to find activities which are enjoyable so that long-term compliance does not become a major limitation.

A precise determination and quantification of a workout's effectiveness can be made by using the heart rate and metabolic responses to a workout. Open-circuit measurements of one subject's metabolic responses were measured a twenty-minute workout sequence on the ABLITERATOR™. The data were analyzed to determine caloric expenditure values of a twenty-minute ABLITERATOR™ workout. The results were used to determine if the ABLITERATOR™ is effective at eliciting a sustained heart rate required for disease prevention, cardiovascular conditioning, caloric expenditure, and weight loss. Finally, comparisons of caloric expenditures were made between the ABLITERATOR™ and other forms of aerobic conditioning.

## Methods:

Two healthy male subjects participated in the testing. The subjects' mean ( $\pm$  standard deviation) for age, height, body mass were 52.5 ( $\pm$  2.1) years, 72.5 ( $\pm$  2.1) in, and 183.5 ( $\pm$  2.1) lb, respectively. All experimental procedures, with any potential risk, were discussed with each subject and university-approved informed consent forms were signed prior to testing. All subjects were free of acute or chronic injury prior to the study. Subjects were familiar with the ABLITERATOR™ exercise device (Fig. 1) and how to perform each movement.

Muscle activity was measured using a standard non-invasive EMG system (BIOPAC Systems, Inc., Goleta, CA). Electromyographical recordings were collected using silver-silver chloride bipolar surface electrodes (EL208S, BIOPAC) placed on the skin overlying the following muscles of the right abdominal and "core" musculature: upper portion of the rectus abdominis (URA), lower portion of the rectus abdominis (LRA), external oblique (EO), rectus femoris (RF), and erector spinae (ES) muscles. An unshielded ground electrode (EL208, BIOPAC) was placed on the skin overlying the acromion process. The electrodes were oriented parallel to the muscle fibers with an inter-electrode distance of approximately 1.5 cm. Prior to electrode application, the skin under each electrode was shaved, if needed, and cleansed with alcohol to reduce the impedance at the skin electrode interface. EMG signals were sampled at 1,000 Hz per channel and amplified (gain of 5000) and band-pass filtered (10-400Hz) using BIOPAC Systems Amplifiers. Signals were then passed through a BIOPAC Systems Model MP150 connected to an IBM i1200 laptop computer for analysis.

The three core ABLITERATOR™ exercises tested, both on the device and on the floor, were the traditional crunch, oblique crunch, and bar rotation exercises. For the crunch motions a hydraulic

piston was compressed and adjusted to provide variable resistance. The exercises target muscle groups of the abdominal musculature and lower back. EMG activity was recorded for the muscle(s) targeted by each exercise, along with trunk (core) stabilizers. In addition, the variable resistances were used on the ABLITERATOR™ device to verify an increase muscle activity while performing higher load movements on the device.

For each exercise tested, the muscle activity was recorded over eight to ten repetitions. The order of exercise and ABLITERATOR™ use was randomly selected for all subjects to eliminate any potential bias due to exercise or device effect. In addition, adequate rest between sets and exercises was permitted so that the potential for fatigue was eliminated.

For the activity testing, one subject trained for twenty minutes on the ABLITERATOR™ while being monitored for their heart rate, ventilation, respiratory quotient, oxygen consumption, and metabolic responses. One design aspect of the ABLITERATOR™ is to allow the user to perform vertical trunk rotations against resistance provided by a flywheel located beneath the standing platen. The speed at which the user rotates determines the resistance and difficulty of movement with the greater the speed the greater the difficulty of movement. Metabolic, heart rate, and gas analysis was performed using a standard open-circuit, non-invasive VO<sub>2</sub> system analyzer (KORR™ Medical Technologies, Inc., Salt Lake City, UT). The subject wore a disposable mask with their breath passing through a hose to the CardioCoach CO<sub>2</sub> gas analyzer, which was hooked up to an IBM ThinkPad laptop computer for analysis. For recording purposes the subject wore a Polar heart rate monitor. The strap was placed over their chest at the level of the xiphoid process of the sternum. The subject's heart rate was recorded throughout the testing. If at any time the subject felt tired or was unable to continue with the workout, they were free to stop and rest and discontinue working out further.

The data were analyzed to determine caloric expenditure values during an ABLITERATOR™ cardio-training workout. In Appendix I the subject's caloric expenditure values were used for comparison to other forms of aerobic exercise.

## Results:

Both subjects were able to complete the entire testing. Throughout the report all values will be presented as the mean  $\pm$  S.D. for each selected measure. Mean data showed that for each exercise tested, the upper and lower portions of the rectus abdominis and the external oblique were recruited (Tables 1 – 4). Because the EMG activity for the rectus femoris was less than 0.1 mv across all exercises tested the muscle was left out of all presentations and can be assumed to be inactive and therefore minimal hip flexion activation occurred during the selected movements.

Table 1 provides the results for the traditional crunch in comparison with the crunch performed on the ABLITERATOR™ exercise device at a low (25 psi pressure) and high (50 psi pressure) resistance setting. While only two subjects were measured on each exercise the data verifies the ABLITERATOR™ to be at least equally effective at recruiting the abdominal musculature as a traditional crunch. A larger population study will be needed to quantify the differences between each exercise and to determine if any statistically significant differences exist.

Table 1. Traditional crunch vs. ABLITERATOR™ crunch – low & high resistance

	<b>mean URA</b>	<b>mean LRA</b>	<b>mean EO</b>
Traditional crunch	21.1 $\pm$ 7.3	16.6 $\pm$ 7.3	12.9 $\pm$ 8.2

ABLITERATOR™ crunch - low	20.6 ± 7.8	25.0 ± 11.1	22.4 ± 8.5
ABLITERATOR™ crunch - high	28.4 ± 10.0	25.5 ± 13.3	22.6 ± 8.6

Values are mean ± S.D. on two subjects on the upper portion of the rectus abdominis (URA), lower portion of the rectus abdominis (LRA), and external oblique (EO) muscle. Low resistance was set at 25 psi and high resistance was set at 50 psi.

Table 2 presents the data for the oblique crunch on both the floor and at the two resistance settings on the ABLITERATOR™. The abdominal muscle activity was higher for each muscle tested on the ABLITERATOR™ at the high resistance setting and comparable for the lower portion of the rectus abdominis and external oblique when the ABLITERATOR™ was set on the low resistance setting.

Table 2. Traditional oblique crunch vs. ABLITERATOR™ oblique crunch – low & high resistance

	mean URA	mean LRA	mean EO
Traditional oblique crunch	10.4 ± 9.5	8.9 ± 13.3	11.1 ± 8.0
ABLITERATOR™ oblique crunch - low	5.3 ± 9.6	8.0 ± 13.3	11.5 ± 8.0
ABLITERATOR™ oblique crunch - high	14.1 ± 9.5	10.0 ± 12.9	28.8 ± 9.1

Values are mean ± S.D. on two subjects on the upper portion of the rectus abdominis (URA), lower portion of the rectus abdominis (LRA), and external oblique (EO) muscle. Low resistance was set at 25 psi and high resistance was set at 50 psi.

Table 3 presents the data for the rotation with a bar and on the ABLITERATOR™ at both slow and fast vertical rotation speeds. While the level of activation of the abdominal musculature was minimal there was comparable abdominal muscle requirement to both slow and fast rotations on the floor to the slow rotation on the ABLITERATOR™ and higher levels of abdominal muscle activation when the fast vertical rotation speed was performed on the ABLITERATOR™.

Table 3. Traditional bar rotation vs. ABLITERATOR™ rotation – slow and fast rotation speeds

	mean URA	mean LRA	mean EO
Traditional bar rotation - slow	3.0 ± 9.8	0.0 ± 13.3	3.8 ± 8.2
Traditional bar rotation - fast	3.7 ± 9.7	0.9 ± 13.3	6.1 ± 8.0
ABLITERATOR™ rotation - slow	5.0 ± 9.5	1.4 ± 13.3	7.1 ± 8.0
ABLITERATOR™ rotation - fast	7.3 ± 9.2	8.2 ± 13.4	10.0 ± 8.1

Values are mean ± S.D. on two subjects on the upper portion of the rectus abdominis (URA), lower portion of the rectus abdominis (LRA), and external oblique (EO) muscle.

In terms of the efficacy of the ABLITERATOR™ as an aerobic training device, using open-circuit measures to determine energy expenditure the subject tested burned an average of 594 kcal/hr and achieved a peak caloric expenditure of 778 kcal/hr at a maximal heart rate of 166 bpm. This

expenditure is above the guidelines for daily energy expenditure necessary for cardiovascular conditioning, weight loss, health, and disease prevention and represents an intensity range of moderate-to-high intensity. Due to the ability of the user to adjust their vertical rotation speed the intensity or the workout can be adjusted for a low-intensity warm-up all the way to a high-intensity interval session. Comparisons of hourly caloric expenditure on the ABLITERATOR™ to other aerobic exercises can be found in Appendix 1.

#### Discussion / Conclusion:

While only two subjects were measured on each abdominal exercise, the data verify the ABLITERATOR™ to be at least equally effective at recruiting the abdominal musculature as a traditional crunch. A larger population study will be needed to quantify the differences between each exercise and to determine if any statistically significant differences exist.

The caloric expenditure values measured on one subject provide support of the efficacy of the ABLITERATOR™ as an aerobic training device. If performed at a moderate intensity for 30 minutes, the subject's caloric expenditure was above the guidelines for daily energy expenditure necessary for cardiovascular conditioning, weight loss, health, and disease prevention. Due to the ability of the user to adjust their vertical rotation speed the intensity or the workout can be adjusted for a low-intensity warm-up all the way to a high-intensity interval session.

#### Acknowledgements:

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Figure 1:



ABLITERATOR™ Exercise Device

APPENDIX I

**Estimated hourly energy expenditure for an ABLITERATOR™ aerobic training workout and selected aerobic activities. \***

Activity	kcal/lb/min	110 lbs.	130 lbs.	150 lbs.	170 lbs.	190 lbs.	210 lbs.
<b>ABLITERATOR</b>	<b>0.0544</b>	<b>359</b>	<b>424</b>	<b>490</b>	<b>555</b>	<b>620</b>	<b>685</b>
Aerobics – low / Pilates	0.0436	288	340	393	445	497	549
Aerobics – moderate	0.0473	312	369	425	483	539	596
Boxing – sparing	0.0626	413	489	564	640	715	791
Cycling - moderate	0.0455	300	355	409	464	519	573
Cycling – fast / spinning	0.0772	509	603	696	788	881	973
Rowing	0.0545	360	425	491	556	621	687
Running – 11:30 min / mile	0.0517	348	411	475	537	601	652
Running – 10:30 min / mile	0.0627	413	489	564	640	715	791
Step Aerobics - moderate	0.0472	311	368	425	481	539	595
Swimming – crawl	0.0582	384	453	524	593	663	733
Walking – 2.5 mph	0.0291	192	228	264	295	331	367
Walking – 3.0 mph	0.0339	228	264	300	343	391	427
Walking – 3.5 mph	0.0390	259	307	367	396	444	492
Weightlifting – circuit	0.0418	276	327	376	427	477	527
Weightlifting –weights	0.0391	259	307	367	396	444	492
Yoga	0.0281	185	220	253	288	321	355

\* The numbers represent the caloric expenditure for a one hour workout, with all values in kcalories. Values used for the ABLITERATOR™ exercise device workout based on mean data recorded from one healthy subject over 20 minutes. For bodyweights not on the chart simply multiple the activities kcal/lb/min by the bodyweight of the individual and then by the number of minutes the individual participates in the activity to determine their overall caloric expenditure.