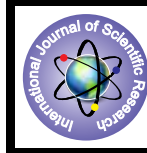


Comparison of Abdominal Muscle Activity Elicited Using the Lean Abs Abdominal Exercise Machine with Popular Abdominal Training Devices and Abdominal Crunch Variations: An Electromyographic Study



Medical Science

KEYWORDS : electromyography, abdominals, exercise, rectus abdominis

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ABSTRACT

One of the greatest challenges trainers, therapists, and physicians face is the selection of appropriate exercises and variations in equipment to best isolate a targeted muscle or muscular region. The purpose of this study was to compare the abdominal muscle activity elicited using the LeanAbs, and the 6 Second Abs abdominal exercise devices with the findings of muscle activity recorded during a traditional crunch, a traditional crunch on stability ball (in two positions), and 4 popular portable abdominal training devices in order to determine if the claims made by the manufacturer are supported by the current research. While all devices elicited abdominal muscle activity when used with proper technique, the "non-crunch emulating" Lean Abs machine dramatically outperformed all other machines and techniques in eliciting high levels of rectus abdominis muscular activity along the full length of the muscle from lower to upper.

Introduction

One of the greatest challenges trainers, therapists, and physicians face is the selection of appropriate exercises and variations in equipment to best isolate a targeted muscle or muscular region. Over the past three decades numerous companies have capitalized on this trend by developing portable abdominal exercise devices. Despite manufacturer claims that their abdominal devices are superior to a crunch, published research fails to support these statements (Francis, Kolkhorst, Penneuci, et al., 1987; Tsai, 2001; and Whiting, Rugg et al., 1999).

The purpose of this study was to compare the abdominal muscle activity elicited using the LeanAbs, and the 6 Second Abs abdominal exercise devices with the findings of muscle activity recorded during a traditional crunch, a traditional crunch on stability ball (in two positions), and 4 popular portable abdominal training devices in order to determine if the claims made by the manufacturer are supported by the current research.

A common technique for determining a muscle's relative involvement during an exercise is to record its electrical activity using electromyography (EMG). Numerous EMG studies have been performed to assess the involvement of the anterior trunk muscles during various types of abdominal exercises (Andersson, 1998; Andersson, Nilsson, Ma and Thorstensson, 1997; Bankoff and Furlani, 1984; Basajian and Deluca, 1985; Beim, Giraldo, Pincivero, Borrer and Fu, 1997; Clark, Holt and Sinyard, 2003; Demont, Lephart, Giraldo, Giannantonio, Yuktanandana and Fu, 1999; Demont, Lephart, Giraldo, Swanik and Fu, 1999; Escamilla, McTaggart, Fricklas, DeWhitt, Kelleher, Taylor, Hreljac and Moorman, 2006; Flint, 1965; Francis et al., 2001; Furlani and Bankoff, 1987; Guimaraes, Aurelio, DeCampos, and Marantes, 1991; Gutin and Lipez, 1971; Juker, McGill, Kropf and Steffen, 1998; Knoble, 1981; Macado De Sousa, and Furlani, 1974; McGill, Juker and Kropf, 1996; Ng, Kippers and Richardson, 1998; Partridge and Walters, 1959; Sarti, Monfort, Fuster and Villaplanta, 1996; Sternlicht and Rugg, 2003; Travell and Simons, 1992; Tsai, 2001; Walter and Partidge, 1957; Warden, Wajswelner and Bennell, 1999; Whiting, Rugg, Colman and Vincent, 1999). Since the principal reason for performing a crunch, or sit-up, is to train the abdominals and not the hip flexors, the motion should be performed to minimize hip flexor activity. In contrast to a sit-up, a crunch is typically performed by lifting only the head and shoulder blades off the floor. This not only minimizes lumbar motion, but also reduces psoas activation, and therefore reduces the compressive and shear stress on the lumbar vertebra (Juker, McGill, et al., 1988 and Nordin & Frankel, 2001). Because of the effectiveness of the crunch in recruiting the abdominal muscles, in reducing hip flexor activity and reducing lumbar stress, the crunch has become a popular training exercise and the standard to which portable abdominal devices are compared.

Methods

Mean EMG recordings from the upper and lower portions of the rectus abdominis from twenty-eight subjects provided the data needed to evaluate the effectiveness of each device. To ensure valid comparisons in our EMG data, range of motion (ROM) and velocity of movement were controlled across devices and subjects.

Subjects

The subjects for this study consisted of twenty-eight male and female college aged students who were majoring in kinesiology and attending a southeastern research university in the United States. Subject selection was limited to individuals with sufficiently low subcutaneous adipose tissue in order to permit accurate measurement of muscle activity. After receiving an explanation of the experimental protocol, each subject practiced the proper technique for using each device and signed a university-approved informed consent form. Subjects were instructed on how to use each device and perform each exercise properly prior to collecting data. Sternlicht (2003, 2007) and his colleagues found that male and female subjects produced similar abdominal activity patterns across devices and as this study parallels his protocol, for that reason we did not separate the data by gender.

Exercise Devices

Previous studies by Sternlicht (2003) investigated the effectiveness of four portable exercise devices. These devices included the Ab Roller Plus (Quantum North America, Glendale, CA), Torso Track 2 (Fitness Quest, Inc., Canton, OH), AB-DOer Pro (Thane Fitness, La Quinta, CA), and the Perfect Abs (Guthy-Renker, Santa Monica, CA). In 2007, Sternlicht and his colleagues published findings comparing electromyography of the stability ball crunch at two positions (1 with the ball at the level of the inferior angles of the scapula (high) and 1 with the ball at the level of the lower lumbar region of the back (low)) to a traditional crunch. In each study, he and his colleagues applied the same methodology and instrumentation. Others such as Escamilla, McTaggart, Fricklas, DeWitt, Kelleher, Taylor, Hreljac and Moorman (2006) followed a similar instrumentation protocol. Figure 1 depicts the four abdominal devices and the two positions of stability ball crunches utilized in previous studies.

Figure 1 Abdominal exercise equipment and stability ball crunch positions



In 2003, Savvier Limited Partners, entered the market with their 6 Second Abs machine, a seated band resistance based compression device intended to simulate the resistance of a crunch. That same year, Larry Thonn of Get Fine, LLC introduced the Lean Abs Machine. The Lean Abs Machine is a “non-crunch-emulating machine”. This novel approach to training the abdominals places the user in a standing position, from which the user leans forward while keeping their back straight, pivoting at the ankle. This movement places the abdominal musculature in both an eccentric and concentric movement as the user leans forward and then returns to the standing position. The addition of resistance bands to the lower swing arm enables the user to apply additional loading in either phase (lean in- eccentric phase, or return to stand – concentric phase). Figure 2 depicts the 6 Second Abs and Lean Abs machines and their related activity positions.

Figure 2: 6 Second Abs and Lean Abs Machines and Activity Positions



Experimental Design

In order to compare the findings of this investigation to the dataset developed by Sternlicht (2003, 2007) the methodology and instrumentation protocols and settings were matched. In accordance with Sternlicht's protocol, each subject was provided

instruction on the proper technique for using each device; subjects were guided through a practice session and then asked to execute the exercise through 8–10 repetitions for each abdominal exercise. Subjects were then instructed to perform each set with a given device through a constant ROM and at a constant speed during the concentric and eccentric phases in order to ensure valid comparisons. The EMG activity was assessed for 5 consecutive movements in each set. The testing order was randomized across all subjects and all data for each subject was collected during a single session.

EMG Recording

Muscle activity was measured using a standard noninvasive EMG system (BIOPAC Systems, Inc., Goleta, CA). Bipolar silver-silver chloride surface electrodes (EL208S, BIOPAC) were placed on the skin overlying the upper portion of the rectus abdominis (URA), middle portion of the rectus abdominis (MRA), and the lower portion of the rectus abdominis (LRA). 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 over each muscle was shaved 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 5,000) and band-pass filtered (10–400 Hz) using BIOPAC Systems amplifiers. Signals were then passed through a BIOPAC Systems Model MP100 connected to an Apple Macintosh computer for analysis.

Results

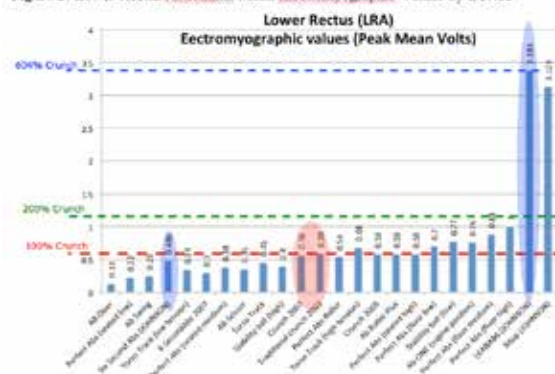
Mean EMG data showed that for each exercise tested, the upper, middle, and lower portions of the rectus abdominis were recruited. The mean electromyography values for the upper and lower portions of the rectus abdominis for each device are depicted in figures 3 and 4.

Lower Portion of the Rectus Abdominis (LRA)

The 6 Second Abs (high tension setting) elicited less LRA activity (82%) than a traditional crunch but greater activity than the AB-Doe, Perfect Abs (seated low-resistance band), Ab Swing, Torso track (low tension), 6 second Abs (low tension), Perfect Abs (seated medium-resistance band), Ab Scissor, Torso track (medium tension), or the crunch on stability ball (high position)

The Lean Abs Machine elicited significantly greater LRA activity than any device by a factor of three and yielded a 604% increase in activity over a traditional crunch, and a surprising 8% increase over a full setup

Figure 3: Lower Rectus Abdominis Mean Electromyographic Values by Device



Upper Portion of the Rectus Abdominis (URA)

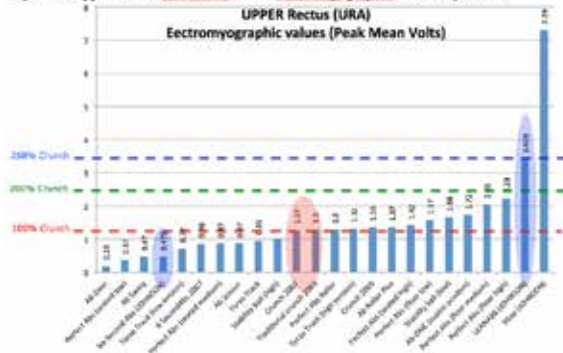
The 6 Second Abs (high tension setting) elicited less URA activity (36%) than a traditional crunch but greater activity than the

AB-DOer, Perfect Abs (seated low-resistance band), or an Ab Swing, all other devices elicited greater URA activity levels.

The Lean Abs Machine elicited significantly greater URA activity than all other devices by a factor of 1.5 and yielded a 268% increase in activity over a traditional crunch.

dominis muscular activity along the full length of the muscle from lower to upper. While the traditional crunch remains an excellent “machine free” option (one that out performs many of the devices on the market), in those situations in which greater abdominal musculature innervation is required the Lean Abs machine fits the bill.

Figure 4: Upper Rectus Abdominis Mean Electromyographic Values by Device



Discussion

As noted by Sternlicht and others, in order to provide greater overload to the abdominal musculature than a traditional crunch, additional resistance must be provided. That additional resistance may be applied in the form of tension (springs or bands) or an increase in the percentage of the body weight to be moved due to the shifting of body position and relocation of the fulcrum point. As therapists, coaches and trainers, the ability to select the appropriate abdominal training tool from a wide array of options, with careful regard for a client's physical restrictions, the position in which the exercise will be performed (supine, seated, or standing); as well as the option to select machines that stress the abdominals musculature minimally to maximally as the client's strength progresses is of great value.

In summary, while all devices elicited abdominal muscle activity when used with proper technique, the “non-crunch emulating” Lean Abs machine dramatically outperformed all other machines and techniques in eliciting high levels of rectus ab-

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