The Effects of EMG Biofeedback on Strength Acquisition

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This study investigated the effectiveness of electromyographic (EMG) biofeedback in maximizing strength gains and integrated electromyographic (IEMG) levels of the quadriceps muscle group resulting from an isokinetic exercise program. Twenty-one male volunteers recruited from physical education classes at a large southwestern university were randomly assigned to one of the following three treatment groups: (1) a biofeedback (BF) trained group, (2) a deception (DEC) trained group, and (3) a nonfeedback (NF) trained group. Subjects were trained and tested for strength by extension on a Cybex Isokinetic Exercise Machine at a speed of 30 degrees per second. Training sessions were performed three times per week for five weeks; pretest and posttest data were based on the best score of three trials of a 1-RM maximum effort. A pretraining to posttraining comparison indicated significant increases in strength (p < .001) and IEMG levels (p < .001) for all treatment groups when a paired t test was applied to the data. A multivariate analysis of covariance (MANCOVA) revealed that the BF trained group showed significantly greater peak torque values than DEC and NF trained groups (p < .01) and produced significantly greater IEMG levels than the NF trained group (p < .05). Overall, these results were taken as supporting the hypothesis that a training program of combined isokinetics and EMG biofeedback produces significant gains in maximal force and IEMG activity of leg-extensor muscles.

Descriptor Key Words: EMG biofeedback; strength; motivation; isokinetic training.

The importance of strength in increasing the effectiveness of muscles is a commonly accepted premise of therapists, physical educators, and sport

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physiologists. This is not a new concept, for as early as 776 B.C. Greek athletes training for the Olympic Games routinely used progressive resistance exercise as a means of enhancing their physical performance (Durant, 1939). Researchers have established that strength is integral to fitness (Baumgartner & Zuidema, 1972; Fleishman, 1964), to motor ability (Clarke, 1978; Schultz, 1967), to speed of movement (Bates, 1967), and to the execution of sport skills (Clarke, 1974 a,b; Kusinitz, 1969). Moreover, the use of progressive resistance exercise for strength development has been shown to increase the strength of connective tissue (Tipton, Matthes, Maynard, & Carey, 1975; Zuckerman & Stull, 1969), and to be essential both in the prevention of athletic injuries (Cahill & Griffith, 1978) and in the rehabilitation of injuries (Allman, 1978; Steele, 1980).

The notion presently exists that there are a minimum of two causes for strength development. One is a morphological change within the muscle tissue brought about by tension activated through training. The other is the development of neuromuscular patterns (motor learning) that enable muscle groups to coordinate effectively into a maximal contraction (Laycoe & Marteniuk, 1971; Moritani & deVries, 1979).

A method for increasing muscle activation levels and improving neuromuscular coordination presently exists with the advent of electromyographic (EMG) biofeedback training. Used in conjunction with more traditional forms of therapy, EMG biofeedback has produced significantly greater and more rapid results than treatment programs without biofeedback. Investigators have successfully used EMG biofeedback for muscle reeducation and muscle strengthening in hemiplegic patients (Basmajian, Kukulka, Narayan, & Takebe, 1975; Middaugh & Miller, 1979, 1980; Middaugh, Miller, Foster, & Ferdon, 1982; Woods, 1985), for maximizing muscular efficiency during submaximal isometric contractions (Lloyd, 1972), for facilitating quadriceps (Gosling, 1979; Kerbs, 1981) and plantar flexor strength (Fugl-Meyer, Nordin, Sjöstrom, & Wählby, 1979) following surgery, and for selectively training the vastus medialis muscle for patella realignment (LeVeau & Rogers, 1980).

Theoretically, EMG biofeedback signals represent specific muscular activity or joint position. In diseased or pathological states, patients need to relearn control over lost sensory-motor functioning and movement. Biofeedback allows such patients to gain control over sensory input by circumventing the pathological focal point that inhibits adequate sensory-motor integration (Wolf, 1980). One can think of feedback as a behavioral system that informs individuals as to whether or not they have reached a desired goal, and biofeedback as a direct physiological loop, the purpose of which is to direct the execution of a specific motor behavior (Olton & Noonberg, 1980).

The intriguing possibilities of biofeedback arise from the use of this feedback to gain control over a feedforward (control) mechanism. In order to have accurate feedforward, the individual needs adequate feedback. It