Electromyographic Recordings of Paraspinal Muscles: Variations Related to Subcutaneous Tissue Thickness

Monica A. Hemingway, Heinz-J. Biedermann, and James Inglis
Queen's University, Ontario

The aim of this study was to assess the effect on EMG amplitude measures of variations in the thickness of underlying tissue between surface electrodes and the active muscle. 20 normal subjects with different amounts of subcutaneous tissue performed comparable constant force contractions for a 45-second period, during which paraspinal EMG recordings were taken. Three measures of subcutaneous tissue thickness were obtained from each subject: Body Mass Index, total body fat as calculated by Durnin's formula, and skinfold thickness at the recording sites. The results show that (i) the greater the thickness of subcutaneous tissue between the surface recording site and the contracting muscles, the lower the recorded electromyographic activity, and that (ii) up to 81.2% of the variance in the EMG measures can be explained by variation in the amount of subcutaneous tissue. These findings support the view that the absolute level of surface-recorded EMG cannot simply be taken at face value. The amplitude of the signal will be affected by, for example, the amount of body fat.

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1Supported by the Physician's Services Inc. Foundation.
2Address all correspondence to Monica Hemingway, Psychology Department, Bowling Green State University, Bowling Green, Ohio 43403.
Structural, behavioral and psychological factors and their interactions have frequently been used to account for back pain (Flor & Turk, 1984; Dolce & Raczynski, 1985; Biedermann, Shanks, Forrest, & Inglis, 1991). A major emphasis has recently come to be placed on the functioning of the neuromuscular system of the back. The National Institute on Drug Abuse (1981) report, for example, reveals that most pain centers now employ EMG biofeedback techniques in order to help patients reduce resting muscle activity. Such treatment is based on the assumption that chronic back pain is, at least in part, caused by elevated paraspinal muscle tension (Cram & Steger, 1983; Cram, 1990; Flor, Haag, & Turk, 1986; Flor, Turk, & Birbaumer, 1985; Nouwen & Solinger, 1979). Through feedback of this muscle activity, patients are taught how to gain control of these muscle contractions, thus reducing muscle tension. While our own patients appeared to learn such control in more than 80% of EMG feedback assisted relaxation trails (Biedermann & Monga, 1985), the actual contribution of relaxation gain/muscle tension reduction to treatment efficacy has been questioned, because the decreases in EMG measures are usually very slight, averaging only about 10% per biofeedback trial (Biedermann, McGhie, Monga, & Shanks, 1987). Other factors may, of course, also strongly influence pain perception. These would include, for example, changes in the viscoelastic properties of other muscles, the alignment of facet joints, changes in connective tissue, and the like.

In spite of these findings, as well as the conclusions of other reviews of the use of EMG amplitude (Dolce & Raczynski, 1985; Teufel & Traue, 1989) which have found, at best, equivocal support for the diagnostic usefulness of this measure, resting EMG is still used as a diagnostic tool in the differential assessment of patient status (Cram, 1990; Ahern, Follick, Council, Laser-Wolston, & Litchman, 1988; Arena, Sherman, Bruno, & Young, 1989, 1991). Such reports reveal, however, that there is little or no consensus about the amplitudes of surface-recorded EMG signals when subjects maintain a static posture. Ahern et al. (1988), for example, found no differences in EMG levels as between chronic back pain patients and normals during quiet standing, whereas Arena et al. (1989) noted elevated tension levels in their patient group.

Given such a lack of consensus, it is surprising to find that few efforts have been made to compare results across those studies that have obtained different outcomes under similar recording conditions. Instead, most investigators have simply acknowledged that in their own studies the reflex-spasm or stress-causality models either have or have not been supported.