

## RELIABILITY OF SURFACE ELECTROMYOGRAPHY IN THE ASSESSMENT OF PARASPINAL MUSCLE FATIGUE: AN UPDATED SYSTEMATIC REVIEW



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### ABSTRACT

**Objective:** The purpose of this study was to review the literature to determine whether surface electromyography (EMG) is a reliable tool to assess paraspinal muscle fatigue in healthy subjects and in patients with low back pain (LBP).

**Methods:** A literature search for the period of 2000 to 2012 was performed, using PubMed, ProQuest, Science Direct, EMBASE, OVID, CINAHL, and MEDLINE databases. Electromyography, reliability, median frequency, paraspinal muscle, endurance, low back pain, and muscle fatigue were used as keywords.

**Results:** The literature search yielded 178 studies using the above keywords. Twelve articles were selected according to the inclusion criteria of the study. In 7 of the 12 studies, the surface EMG was only applied in healthy subjects, and in 5 studies, the reliability of surface EMG was investigated in patients with LBP or a comparison with a control group. In all of these studies, median frequency was shown to be a reliable EMG parameter to assess paraspinal muscles fatigue. There was a wide variation among studies in terms of methodology, surface EMG parameters, electrode location, procedure, and homogeneity of the study population.

**Conclusions:** The results suggest that there seems to be a convincing body of evidence to support the merit of surface EMG in the assessment of paraspinal muscle fatigue in healthy subject and in patients with LBP. (*J Manipulative Physiol Ther* 2014;37:510-521)

**Key Indexing Terms:** *Electromyography; Reliability; Low Back Pain; Muscle Fatigue; Review; Systematic*

Low back pain (LBP) is a common and complicated disorder with reported high prevalence rates in many countries.<sup>1-4</sup> Almost 80% of people will have at least 1 episode of LBP in their lifetime,<sup>5</sup> and 30% to 40% will experience LBP each year.<sup>2,6</sup> In Iran, LBP was reported to be one of the most common conditions affecting all populations with different prevalence rates, ranging from 17% for school children, 62% for nurses to more than 80% for pregnant

women and surgeons.<sup>3,7-9</sup> Low back pain is one of the most common reasons for seeking medical care.<sup>10</sup> It is a costly condition with short- and long-term absenteeism and early retirement.<sup>5,11</sup> Low back pain was reported to be the main cause for 33.7% of work absenteeism during the past month in Iranian nurses.<sup>3</sup> Many causes such as anatomical, biomechanical, and psychophysiological factors were suggested for LBP.<sup>12,13</sup> In addition to degeneration of the lumbar spine,

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reduced muscle strength and endurance and impaired function are also common in patients with chronic LBP.<sup>14,15</sup> There is adequate evidence to suggest that highly fatigable back muscles may predispose individuals to the development of LBP.<sup>16,17</sup> Although the exact pathophysiology of LBP is still not clearly understood, it seems that evaluation of paraspinal muscles is of great value in the assessment of such patients.

Among available objective methods, magnetic resonance imaging,<sup>18</sup> ultrasonography,<sup>19,20</sup> and needle and surface electromyography (EMG)<sup>21-24</sup> have become increasingly common methods to assess muscle dimension and activity in healthy subjects and in patients with LBP. Despite many studies carried out in this area, the superior method is yet to be demonstrated in terms of being reliable, valid, convenient, noninvasive, and easily available to use. Surface EMG appears to be more convenient for both the patients and the researchers to analyze lower back muscles fatigue in laboratory studies and in clinical trials.<sup>25</sup> Despite suggested potential usefulness of the surface EMG approach in previous studies, this technique still reveals limitations in repeatability, reliability, and sensitivity to electrode location and type of muscle contraction and others.<sup>25</sup>

Of various accessible techniques for using surface EMG, power spectral analysis, which focuses mainly on a single frequency parameter, the median frequency, as a measure of muscle function, is frequently used to evaluate muscle fatigue in healthy subjects and in patients with chronic LBP.<sup>26-29</sup> As the energy of muscle has a frequency spectrum, the surface EMG signal can be displayed with its range of frequencies. The power spectrum is the distribution of frequency components of the surface EMG signals.<sup>26-29</sup> As the muscle becomes fatigued, the median frequency of the EMG power spectrum shifts to lower frequencies due to altered muscle fiber recruitment and other changes in the contractile properties.<sup>30,31</sup>

A number of shortcomings were found in the methodology of previous studies, which might help to understand some of the differences in conclusions of these studies. Some of them are as follows:

1. Small sample size.
2. Lack of a homogenous study population.
3. Different definitions provided for LBP.
4. Lack of valid and reliable or sensitive EMG parameters.
5. Lack of a standard method for evaluating paraspinal muscle function and fatigue.
6. Lack of a standardized location for electrodes.

The purpose of this study was to systematically review the previously published studies (2000-2012) concerning the reliability of surface EMG to assess lower back muscle fatigue in healthy subjects and in patients with chronic LBP. As published articles from 1985 to 1999 concerning the application of surface EMG in the assessment of LBP were included in the previous review of the first author and his colleagues,<sup>24</sup> the current review was performed on studies published from 2000 to 2012.

## METHODS

The present systematic review was conducted according to the guideline of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA).<sup>32</sup> The study was given ethical approval from the University of Social Welfare and Rehabilitation Sciences.

### Search Strategy

To identify studies concerning the reliability of surface EMG in the assessment of lower back muscle fatigue, a literature search was carried out for the period of 2000 to 2012, using PubMed, Science Direct, OVID, EMBASE, MEDLINE, CINAHL, and ProQuest databases. The search strategy was used according to the PRISMA statements, using the following items: participants, interventions, comparisons, outcomes, and study design. The following keywords were also used: "paraspinal muscles," "electromyography," "muscle fatigue," "endurance," "median frequency," "low back pain," and "reliability." In addition, references given in the relevant publications were also searched.

### Study Selection

**Inclusion Criteria.** A literature search was performed to locate the relevant articles. The inclusion criteria of studies were as follows:

1. The reliability of surface EMG was investigated.
2. Paraspinal muscles were assessed.
3. Surface EMG was used to assess muscle fatigue in healthy subjects and/or in patients with chronic LBP.
4. Studies were published in English language.

**Exclusion Criteria.** Studies in which needle EMG was used, muscles other than paraspinal were assessed, and muscle fatigue was not investigated and which was not in English language were excluded.

### Data Extraction and Methodological Quality

Two reviewers (NR and ShShA) independently selected potentially relevant studies from different databases. Disagreements were discussed until consensus was reached. Studies were included if they met all mentioned 4 inclusion criteria. If based on the title and abstract, it was not clear whether an article should be included, the whole article was checked (Fig). These 2 reviewers also read all the abstracts, and the third and fourth reviewers (MAMB and BM) separately have read a random sample of the abstracts. A consensus meeting was arranged to reach agreement on any differences among all reviewers.

The outcome of a study was identified as "positive" if the authors concluded that surface EMG is a reliable method to assess paraspinal muscle fatigue in patients with LBP, in healthy subjects, or in a specific group or particular

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