Lumbar muscle fatigue and recovery. Evaluation of electromyography in patients with long-term low-back pain and in healthy subjects

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Abstract

Background: Lumbar muscle function is considered to be an important component of long-term low-back pain. The change in the median frequency of the power spectrum of the electromyographic (EMG) signal is commonly used to estimate muscle fatigue.

Aim: The main purpose was to evaluate a test method to estimate lumbar muscle fatigue using frequency analysis of the electromyographic signal during isometric contraction.

Methods: In the different studies, 73 healthy subjects participated; 55 of these constituted a reference group which was compared to 57 patients with long-term low-back pain. The subjects performed a back extensor test in seated position: maximal voluntary contraction (MVC) torque, 45 s isometric fatigue contraction at 80% of MVC, 5 s contractions after 1, 2, 3 and 5 min in the recovery period. Surface EMG was recorded from the lumbar muscles bilaterally at spinal levels L1 and L5. To study reliability, this test was repeated five times by 11 of the healthy subjects and once by 20 of the patients. In a further study, 15 of the healthy subjects performed the fatigue test at 40% and 80% of MVC with both 2 cm and 4 cm interelectrode distances. EMG variables were *initial median frequency*, median frequency *slope* (obtained from linear regression of the fatigue contraction) and *recovery half-time* (obtained from non-linear regression of the recovery data). Activity, participation and other health-related factors were estimated by the patients in five questionnaires.

Results: The reliability was somewhat higher for patients (ICC>0.6) than for healthy subjects. The initial median frequency and, to a greater extent, the slope were sensitive to the exerted torque. The patients differed from the healthy subjects by lower MVC torque, higher initial median frequency at L5, and by flatter slope and longer recovery half-time at both lumbar levels. Using logistic regression entering EMG initial median frequency, slope and recovery half-time in combination with MVC, about 80% of the patients and the healthy subjects could be correctly classified. By analyses of individual linear and non-linear regressions, it was found that patients with not significantly negative slopes and/or not exponential-like EMG recovery had lower self-efficacy and more activity limitations. Female patients had significantly flatter slopes, lower physical functioning and self-efficacy than male patients. The results indicate that the ability to fatigue the lumbar muscles in a 80% MVC contraction might be a healthy sign.

Conclusion: The most important findings concerning the validity of the present test are that patients with long term low-back pain and back-healthy subjects could be correctly classified in about 80% of the cases, and that subjective assessments of health-related factors were related to EMG fatigue and recovery.

Key words: Disability, electromyography, exponential, force level, gender, healthy subjects, interelectrode distance, low-back pain, erector spinae, maximal voluntary contraction, muscle fatigue, recovery, reliability, validity.