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Erector spinae SEMG activity during forward flexion and re-extension in ankylosing spondylitis patients

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Abstract

Objective: To compare erector spinae muscle (ESM) activity as measured by surface electromyography (SEMG) in lumbar flexion from the upright position in men with ankylosing spondylitis (AS) and healthy males, and to study associations between pain, lumbar mobility and ESM activity. **Methods:** Surface EMG was undertaken at the L1-2 and L4-5 levels in 11 men with AS taking part in a rehabilitation course at the Rheumatism Foundation Hospital, and in 10 pain-free male controls, while the subjects were bending forward. **Results:** During full flexion ESM SEMG activity was significantly greater in patients with AS than in the controls. Relaxation was evident during flexion in all of the controls but in only some patients with AS. Lumbar mobility correlated negatively with ESM activities. No relationship between pain and ESM activity was evident. Some AS patients reported pain while ESM activity was being measured. **Conclusion:** Decreased lumbar mobility rather than pain explains ESM activity during full flexion in patients with AS.

Keywords: Ankylosing spondylitis; EMG; Erector spinae; Lumbopelvic rhythm

1. Introduction

Ankylosing spondylitis (AS) is a chronic inflammatory disease predominantly affecting the axial skeleton and sacro-iliac joints. It is also associated with peripheral joint inflammation and extra-articular-system symptoms. In AS, in addition to progressive decreases in ranges of motion, changes in body posture, stiffness, pain and fatigue patients experience difficulties with activities of daily life [1]. Diagnosis of AS is based on assessment of symptoms, evidence of decreased mobility and radiological changes in the sacro-iliac joints [2,3].

Despite stiffening, spinal mobility should be maintained in AS [4]. AS patients benefit from rehabilitation [5] and physiotherapy is regarded as an important element in treatment [6].

Several tests of mobility (determination of finger-to-floor distance, and of capacities for chest expansion, thoracolumbar rotation and lateral rotation) have shown to be sensitive in relation to detection of improvements during short-term clinical trials. Other tests (Schober, and determination of thoracolumbar flexion and occiput-wall distance) were not sufficiently sensitive [7]. Results of the Schobers test and of measurement of thoracolumbar flexion correlated significantly with specific radiologically demonstrable spinal changes, and reproducibilities of results between and within testers were also good (ICC range from 0.84 to 0.98) [8]. Although changes in results of mobility tests provide useful short- and long-term follow-up information, they do not indicate how the back muscles are functioning. Back-muscle function can be evaluated by means of needle or surface electromyography (SEMG). Surface EMG has been used in numerous studies of low back pain (LBP) [9–15].

No information on changes in the lumbopelvic rhythms of AS patients as determined by SEMG has been published. Spinal pain and stiffening in AS patients can alter lumbopelvic rhythm, can lead to absence of the flexion–relaxation phenomenon and can result in differences in activation patterns of erector spinae muscles (ESM). The aim of rehabilitation is to ease the spinal pain and restore spinal mobility. Traditionally, progression of AS is followed

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by means of measurement of flexion mobility. If the aims of rehabilitation are achieved, changes in the activation of paraspinal muscles could be evident. Reproducible methods of evaluation of function and of changes in activation of paraspinal muscles are needed.

Normally, in the upright position, ESM activity is scarcely noticeable. However, it increases markedly during flexion. During full flexion no activity is evident but during re-extension, activity increases significantly. Patients with non-specific low back pain exhibit ESM activity when standing at rest [9]. Normally, there are no significant differences between lumbar segments in relation to symmetrical flexion–extension movement [16,17]. EMG activities in individuals with low back pain is lower than those activities of healthy individuals doing similar work [10,11].

This study was part of a project aimed to clarify the possibilities of using surface EMG to follow up the effects of rehabilitation of AS patients. The purpose of this study was to compare the effects of mobility of the spine and pain on ESM activity as measured by EMG in patients with AS and controls during forward flexion.

2. Subjects and methods

The study involved 11 male patients having AS diagnosis and who attended a rehabilitation course at the Rheumatism Foundation Hospital in Heinola, and 10 male controls free from pain. The mean age of the patients was 36.5 years (S.D. 10.2 years), that of controls 38.3 years (S.D. 10.0 years). The mean duration of AS in the patients was 8.4 years (range 1–30 years). The mean weight of the patients was 78.4 kg (S.D. 12.4 kg), of the controls 79.4 kg (S.D. 8.4 kg). The mean height of the patients was 178.6 cm (S.D. 6.8 cm), of the controls 178.9 (S.D. 6.5 cm). All of the patients met the modified New York criteria for AS [18]. Among the exclusion criteria for the controls were back pain or any diagnosed back disease. Seven of the patients were taking sulphasalazine medication (Salazopyrin). One was taking a corticosteroid orally. All of the patients were taking non-steroidal anti-inflammatory drugs as necessary.

This study was approved by the ethical committee of Rheumatism Foundation Hospital. Lumbar mobility was measured in the sagittal plane by means of the Schober test [14], and by measurement of finger to floor distance [14], of thoracolumbar flexion [5] (in cm), and of lumbar flexion, using an inclinometer [19]. The patients were asked to indicate their present back pain on a drawing and a visual analogue scale (VAS) before and after the experiment.

2.1. Measurement of performance

Each subject was asked to perform the experimental task three times while standing with his feet 15 cm apart. Each task was divided into three phases. In phase 1 each subject had to flex his trunk forward from the erect position as far as possible. In phase 2, each subject had to maintain full flexion. In phase 3 each subject had to revert to the initial upright position. Ten seconds were allowed for performance of each task (3 s for phase 1, 4 s for phase 2, 3 s for phase 3). Timing was controlled by means of a metronome (9). Before measurement each subject could practice forward flexion and re-extension once.

2.2. Electromyographic recordings

During tasks, ESM activity was monitored by means of SEMG, and the picture was synchronized with the EMG curve, using ME3000p equipment (Mega Electronics Ltd., Kuopio, Finland). Skin-surface electrodes were placed over the ESM, at the level of the spinous process, at L1-2 and L4-5, 2 cm bilaterally from the midline. While the electrodes were being positioned, each subject stood slightly flexed forward, to prevent the electrodes becoming detached once full flexion had been achieved. Recording of raw EMG signals took place at a frequency of 1000 Hz, via four channels, with EMG data were normalized by determining the signal amplitude percentage of reference voluntary contraction (RVC).

Each subject flexed forward then stood upright again three times. Each phase of the second task performance was analyzed. EMG activity at levels L1-2 and L4-5 was determined in the upright position. EMG activity during the excentric work (phase 1) was also determined at both levels. The beginning of the excentric work phase was defined from the EMG curve. The first 0.1 s was ignored and the next 0.5 s was analyzed. EMG activity during relaxation (phase 2) was determined back from the beginning of the concentric phase. Again, the first 0.1 s was ignored. One second of the relaxation phase was analyzed. Because it was difficult to define the beginning of the concentric phase (phase 3) the first 0.5 s of it was ignored. A one-second period was then analyzed. In all phases, the maximum activity level (90%) was analyzed.

Reproducibility of measurement of surface EMG between testers was determined. Two physiotherapists (PT) blind to each others findings, measured surface EMG activity of the back muscles in six male patients with AS and five healthy male controls. During measurement, the subjects bent forward from a standing position. Each PT placed the electrodes independently. The sites for the electrodes had not been marked. The reproducibility of measurements in the standing position at rest was good (Lin's concordance coefficients [20] (CCC) 0.91 and 0.71) at both L4-5 and L1-2 levels. Reproducibility in relation to movement was better at the L4-5 level. Reproducibility in relation to subjects completely bent forward was poor unless flexion relaxation had occurred [21].

2.3. Statistical analyses

Student's *t*-test was used to determine significances of differences between results relating to normally distributed paired samples. For asymmetrically distributed or categorial variables, the non-parametric Mann–Whitney test was used.