ABDOMINAL PRESSURIZATION AND MUSCLE ACTIVATION DURING SUPINE TRUNK CURLS

Alf Thorstensson, Anna Bjerkefors, Maria Ekblom and Fredrik Tinmark

The Swedish School of Sport and Health Sciences and Department of Neuroscience, Karolinska Institutet, Stockholm, Sweden

KEY WORDS: sit-ups, intra-muscular EMG, training exercises

INTRODUCTION: Trunk curls are common exercises in sports training. A multitude of practical recommendations exist on how to best perform this type of exercise to reach a specific effect. Since abdominal muscles can contribute to breathing, it was thought of interest to study the effects of systematic variations in breathing on the pattern of abdominal muscle activation during trunk curls. Of particular interest was the influence of fluctuations in the intra-abdominal pressure (IAP), since changes in IAP have been shown to be coupled to the activation of the innermost abdominal muscle, the Transversus abdominis (TrA), and also to be able to contribute to an extensor moment of the trunk.

METHODS: Ten healthy young adult females performed straight trunk curls from a supine position with bent knees. The movement speed was set by a metronome and the upward and downward phases each lasted approximately 2 s. Six different variants were carried out: 1) spontaneous breathing, 2) inhalation during the upward and downward phases, 3) exhalation during the upward and downward phases, 4) breath-holding on a sub-maximal level, 5) breath-holding on a maximal inhalation level, and 6) breath-holding on a maximal exhalation level. Kinematics was obtained with a position transducer and air flow with a respiratory flow-meter. Intramuscular electromyography (EMG) was recorded via bipolar fine-wire electrodes placed under the guidance of ultrasound in the TrA, Obliquus Internus (OI), Obliquus Externus (OE), and Rectus Abdominis (RA) muscles on the right side. IAP was obtained with a pressure-sensitive tip-transducer introduced into the gastric ventricle via the nose. Root mean square EMG and mean IAP were calculated for a 1-s-interval in the middle of the upward and downward phases, respectively, and normalized to the EMG obtained in an isometric maximal voluntary sagittal trunk curl in a supine position and of the IAP in a maximal voluntary pressurization of the abdominal cavity (Valsalva) in the same position.

RESULTS: The overall range of relative EMG-levels was 6-72%. The activation of TrA was lower than that of the other muscles (6-29% versus 19-72%). All muscles showed higher activation during the upward than the downward phase (ranges: 13-72% versus 6-56%). Breath-holding in maximal exhalation showed higher EMG-values than the spontaneous breathing for OE and RA both in the upward and downward phases. There was no difference in IAP between spontaneous breathing and steered breathing on a sub-maximal level, whereas breath-holding on a maximal level caused higher IAPs, both for inhalation and exhalation.

DISCUSSION AND CONCLUSION: There was no or only minor effects on abdominal muscle activation levels of breathing in or out or holding breath on a sub-maximal level during the execution of a straight trunk curl in a supine position. Holding breath in maximal exhalation caused an increase in trunk flexor muscle activity, possibly to overcome a combined effect of an increased intra-abdominal pressure and decreased leverage due to the compressed abdomen. In the maximal inhalation situation, a possible opposing effect of increased abdominal pressure might have been counteracted by an improved leverage caused by an expanded abdominal cavity, resulting in an unchanged need for trunk flexor activation.