Stabilizing Function of Trunk Flexor-Extensor Muscles Around a Neutral Spine Posture

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Abstract

Study Design.

This study examined the coactivation of trunk flexor and extensor muscles in healthy individuals. The experimental electromyographic data and the theoretical calculations were analyzed in the context of mechanical stability of the lumbar spine.

Objectives.

To test a set of hypotheses pertaining to healthy individuals: 1) that the trunk flexor-extensor muscle coactivation is present around a neutral spine posture, 2) that the coactivation is increased when the subject carries a load; and 3) that the coactivation provides the needed mechanical stability to the lumbar spine.

Summary of Background Data.

Theoretically, antagonistic trunk muscle coactivation is necessary to provide mechanical stability to the human lumbar spine around its neutral posture. No experimental evidence exists, however, to support this hypothesis.

Methods.

Ten individuals executed slow trunk flexion-extension tasks, while six muscles on the right side were monitored with surface electromyography: external oblique, internal oblique, rectus abdominis, multifidus, lumbar erector spinae, and thoracic erector spinae. Simple, but realistic, calculations of spine stability also were performed and compared with experimental results.

Results.

Average antagonistic flexor-extensor muscle coactivation levels around the neutral spine posture as detected with electromyography were 1.7 ± 0.8% of maximum voluntary contraction for no external load trials and 2.9 ± 1.4% of maximum voluntary contraction for the trials with added 32-kg mass to the torso. The inverted pendulum model based on static moment

equilibrium criteria predicted no antagonistic coactivation. The same model based on the mechanical stability criteria predicted 1.0% of maximum voluntary contraction coactivation of flexors and extensors with zero load and 3.1% of maximum voluntary contraction with a 32-kg mass. The stability model also was run with zero passive spine stiffness to simulate an injury. Under such conditions, the model predicted 3.4% and 5.5% of maximum voluntary contraction of antagonistic muscle coactivation for no extra load and the added 32 kg, respectively.

Conclusions.

This study demonstrated that antagonistic trunk flexor-extensor muscle coactivation was present around the neutral spine posture in healthy individuals. This coactivation increased with added mass to the torso. Using a biomechanical model, the coactivation was explained entirely on the basis of the need for the neuromuscular system to provide the mechanical stability to the lumbar spine.