The startle response during whiplash: a protective or harmful response?

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KEY POINTS FROM THIS STUDY:

1) During whiplash collisions, initially relaxed occupants exhibit brisk, stereotypical muscle responses consisting of postural and startle responses that may contribute to the injury.

2) “The neck neuromuscular response to a rear-end impact consists of a postural response and a startle response elicited by a multisensory stimulus (somatosensory, acoustic, and vestibular) associated with the vehicle impact.”

3) “During a rear-end collision, afferents from the somatosensory, acoustic, and vestibular systems are activated and trigger a startle response in the neck muscles.”

4) These authors sought to determine if the startle response elicited during a rear-end collision contributes to head stabilization or represents a potentially harmful, overreaction of the body. “In the context of a rear-end collision, it is not clear whether these reflex actions are protective and thus beneficial or potentially injurious and therefore harmful.”

5) Three experiments were performed using 33 different subjects. The analysis included the use of surface electromyography, and head accelerations were measured using an accelerometer array.

6) The startle response represents an overreaction that increases the kinematics in a way that potentially increases the forces and strains in the neck tissues. [Key]

7) “Neck muscle activity begins about 50–100 ms after vehicle acceleration onset, early enough to influence peak head and neck kinematics.” There is evidence that neck muscles are a contributor to other neck tissue injuries during whiplash mechanism.

8) “The time period over which the neck muscles are active overlaps the time period during which peak acceleration and displacement of the head and neck occur. This overlap suggests that muscle-induced strains and motion-induced strains in the posterior neck tissues potentially coincide and cause more severe whiplash injury and related symptoms following a rear-end collision.”

9) “In experimental rear-end collisions, subjects who reported temporary neck pain exhibited larger startle responses in their posterior neck muscles than did subjects who did not report neck symptoms.”
Based on prior studies, “injuries sustained during a rear-end car collision could be exacerbated by a startle response that increases neck muscle activity during a time when the posterior neck tissues may be vulnerable.”

During whiplash, the startle response inhibits muscle tone; therefore, the “startle response is potentially harmful and ill-adapted for whiplash collision exposures.”

The startle response during a rear-end collision “decreased the whiplash-evoked neck muscle response by 16–29%.” [Muscles protect joints. Joint injuries (facet/disc) are primarily responsible for chronic whiplash pain. Startle reduces muscle protection of joints, increasing whiplash injury and chronicity].

“These kinematic differences suggest that the startle response evoked by a rear-end collision may be more harmful than protective.”

“Our findings suggest that the startle response evoked by a rear-end collision may increase the risk of certain whiplash injuries.”

“The cervical facet joints are a source of neck pain in 40–68% of patients with chronic whiplash injuries, and excess strain in the facet joint capsule can occur during whiplash exposures.” “The neck multifidus muscles insert directly onto the [facet] capsule.”

“Posterior neck muscle activity, and multifidus muscle activity in particular, elicited by the collision may exacerbate cervical facet capsular ligament strain at a moment when the ligament is already being strained by the collision-induced intervertebral motion.”

“Our results provide additional support for the potential role of the startle response in exacerbating certain whiplash-related neck injuries.”

Although startle responses are generalized body reactions to intense stimuli and are generally thought to protect the body from potential injury by drawing in the limbs and stiffening the body, during whiplash they tend to inhibit cervical muscle tone and increase cervical spine injury.

COMMENTS FROM DAN MURPHY

This article may help explain why some patients can be injured in very low impact scenarios; they are injured as a consequence of the startle response, caused by a cervical neuromuscular multisensory response from somatosensory, acoustic, and vestibular afferents associated with the vehicle impact.