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Projekt: Whiplash

Imagine yourself driving when a car behind you rear-ends your vehicle. The impact pushes your car forward. It takes about 100 milliseconds for your body to catch up to the forward movement. Your shoulders travel forward until they are under your head, and your neck extends forward as your head tilts slightly down toward your steering wheel. You step on the brakes, bringing the car to an abrupt halt. The sudden stop throws your head and neck backward, and they bounce against the headrest. In a matter of seconds, you've experienced the classic mechanism of injury for whiplash.

About 20 percent of people involved in rear-end collisions later experience symptoms that center in the neck region. Although most of these people recover quickly, a small number develop chronic conditions that result in severe pain and sometimes disability.

Signs and symptoms

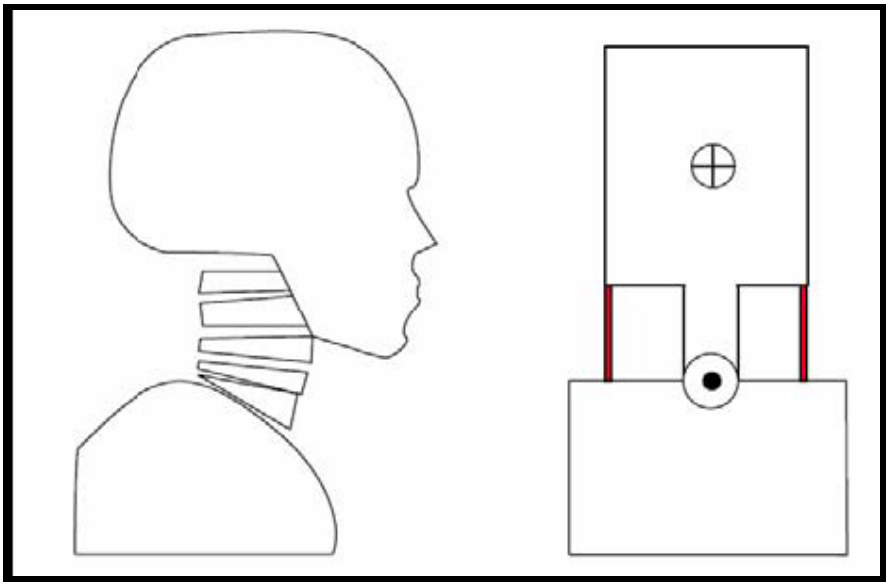
People who experience whiplash may develop one or more of the following symptoms, usually within the first two days after the accident:

- Neck pain and stiffness
- Headaches
- Pain in the shoulder or between the shoulder blades
- Low back pain
- Pain or numbness in the arm and/or hand
- Dizziness
- Ringing in the ears or blurred vision
- Difficulty concentrating or remembering
- Irritability, sleep disturbances, fatigue

(From http://orthoinfo.aaos.org/fact/thr_report.cfm?Thread_ID=232&topcategory=Neck)

Project
Use a model where the head and the neck together form a rigid body which rotates around the upper part of the body. Decide the model for the head and the neck yourselves. The muscles are modeled by two elastic rubber strings, one in front of the head and one behind. Rubber strings act as springs when they are stretched, but cannot be compressed.

You may decide whether the car (read the driver) collides with a wall or if another car hits it from behind when it stands still waiting at red light. In both cases you may consider the moving car to have the velocity 50 km/h and that the first case the car stops immediately; the head, however, continuing directly after the collision with the velocity 50 km/h. In the second case, assume an inelastic collision and estimate from that the new velocity of the two vehicles. Assume that the driver uses a safety belt but the car has no support for the neck.



Consider that the muscles have a critical maximal force corresponding to the brake of the rubber spring. You must also assume an initial acceleration of the car in the second collision type since the joint between neck and body will get the same acceleration.

You may also consider if there are differences between adult persons and children and different values of velocities.

You may find geometrical difficulties when you need to determine the moment arm from the joint to the rubber string; then approximate.

(Idea and figure: Tony Burden, Mechanics, KTH)