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## **Injury with Low-Speed Collisions**

By Jeffrey Tucker, DC, DACRB

Can pain and dysfunction develop from a low-velocity collision without attendant injury? "Low-speed" impact refers to 1-2 miles per hour and goes up to 20-25 mph. "Moderate speeds" are 25-40 mph and "high speeds" are 40 mph and over.

Jackson<sup>16</sup> and States<sup>13</sup> estimate that 85 percent of all neck injuries seen clinically result from automobile crashes, and of those due to such collisions, 85 percent result from rear-end impacts. Morris reported that rear-end impacts of as little as five mph can give rise to significant symptoms.<sup>17</sup> The dynamic and vehicle factors that contribute to rear-end collision injury are:

- vehicles involved
- speed differential
- vehicle weight
- location of impact
- direction of impact
- head restraint location
- seat failure
- seat back angle
- seat back height

Wiesel states that approximately 10 percent of the occupants of the stricken vehicle in rear-end automobile collisions will develop whiplash syndrome.<sup>10</sup> Approximately 10-15 percent of patients suffering from cervical soft tissue injuries following motor vehicle accidents fail to achieve a functional recovery.

Emori and Horiguchi state: "Whiplash, in some cases, persists for years but usually no obvious symptoms show up with radiological or other quantitative diagnostic techniques."<sup>9</sup> Our present technology does not

permit precise identification of deranged soft tissues.

Research quoted by White and Panjabe<sup>11</sup> states that an eight mph rear-end collision may result in a two g force acceleration of the impacted vehicle and a five g force acceleration acting on the occupant's head within 250 msec of impact. (One g equals an acceleration of approximately 32 ft./sec.) Car crashes happen in literally one/two eye blinks. The point is that the head and neck experience more g forces than the car in low-speed impacts.

Kenna and Murtaghsay state: "It is wrong to assume that maximum neck injury occurs in a high-speed collision; it is the slow or moderate collision that causes maximum hyperextension of the cervical spine. High-speed collisions often break the back of the seat, thus minimizing the force of hyperextension."<sup>21</sup>

A major dilemma exists for the auto manufacturer, insurance companies, and the consumer of autos. Each would like the vehicle to provide the maximum protection for the occupant with the minimum material damage to the vehicles during a collision. Stiffer cars with spring-like rear bumpers that increase the rebound have less damage costs, however the occupant experiences an increased neck snap and the potential for greater injury. When a car gets struck from the rear by another auto, the very first thing that happens is the struck car is accelerated. The occupant of the struck car experiences higher speeds as it attempts to "catch up" with the car. Navin and Romilly state: "This relative movement of the head to the shoulder during the rebound is the likely cause of neck injuries as this is the point at which dynamic loading of the neck will be maximum."<sup>8</sup> They conclude: "Of major concern to researchers is the lack of structural damage present below impact speeds of 15 kmh. This indicates that the bumper system is the predominant system of energy absorption between the impact and the occupant. It was also observed that deflection of the seatback tends to pitch the occupant forward, with the shoulder displacement leading the head. This relative head to shoulder motion is the likely source of whiplash injury."

Research has shown that high impact forces are transmitted directly to the occupant in low-speed impacts and that the vehicle does not begin to crush until impact speed exceeds 15 or 20 mph.<sup>1,13</sup> Severy<sup>1</sup> demonstrated a 10 mph impact produced total collapse of only 2 1/2 inches in the rear structures of the impacted vehicles. Therefore, minor property damage does not necessarily equate to minor injury. The most important question is not, "What is the damage to the vehicle?" but, "What was the acceleration to the vehicle that you were in?" Injury will occur because of the acceleration differences between the different inertial parts of the occupant's body, especially from the person's head, versus trunk inertial acceleration

differences.

Navin and Romilly have demonstrated that, "Rear vehicle impacts between 5-12 mph indicate that some vehicles can withstand a reasonably high speed impact without significant structural damage. The resulting occupant motions are marked by a lag interval, followed by a potentially dangerous acceleration up to speeds greater than that of the vehicle."<sup>8</sup>

Severy<sup>1</sup> demonstrated conclusively that seemingly harmless low-speed rear-end collisions were capable of producing damaging forces to the head and neck. Severy and associates recorded head accelerations as great as 11.4 g. Most research evidence suggests that the major injuries are due to the hyperextension phase of the cervicothoracic spine.

### **Factors that Influence the Extent of Injury**

Headrests are the best protection in rear-end collisions. However if the headrest is set too low, the head is able to roll over the top of the headrest, producing even more hyperextension.<sup>2</sup>

Emori's experiments were to simulate relaxed necks of unexpected passengers in struck vehicles. Without a headrest, the neck extension can become almost 60 degrees, which is a potential danger limit of whiplash at collision speeds as low as two mph.<sup>9</sup>

The exact position of the head at the moment of impact is important to know. If the head is turned, the injury will be greater on the side it is turned to. When head rotation is present, the pattern of tissue injury is potentially more severe.<sup>19</sup>

A surprise collision will usually cause more injury because the ligaments will be injured more than the muscles. When a person knows they are going to be struck, they will tense up the muscles and therefore injure the muscles first. MacNab states: "In impacts up to 15 mph the right front seat passenger stands in greater danger of injury than does the driver, because the driver can brace himself to some extent by holding onto the steering wheel."<sup>14</sup>

Common predisposing factors include degenerative joint disease and spinal stenosis. The potential for injury is increased because the neck is less resilient.

The seatback stiffness requires investigation. The harder/stiffer the seatback the less forward acceleration and therefore the less injury. The less stiffer the seatback the more forward acceleration and therefore the risk of increased injury.

Jackson states: "The belt has very little if any deterring effect on the cervical spine as the head and neck continue forward motion. Even the addition of a shoulder harness will not relieve but will only increase the forces which must be absorbed by the head and neck, although such a harness may prevent contact injuries." <sup>12</sup> Seat belts save lives by preventing occupants from going through the windshield, but they contribute to the neck injury.

The Office of the Chief Scientist (London), Department of Health and Social Security, had this comment regarding seat belts in 1985: "We predicted an increase in the case of two injuries: sprains of the neck and fractures of the sternum. Both were confirmed. The other apparent increase in a major injury which was not predicted was abdominal injuries of organs other than the kidney and bladder."

Clemens and Burrow <sup>20</sup> report that any shoulder restraint mechanism in front-end collision increases the degree of cervical flexion, with potential for injury.

The car fender or bumper is designed to avoid or reduce damage in a low-speed collision. It is not a safety device to prevent or reduce injuries to people in the car. The government requires bumpers on passenger cars to prevent damage to the car body and parts, such as headlights, tail lights, grille, hood and trunk latches, at barrier impact speeds of up to 2 1/2 mph. This is equivalent to a five mph crash into a parked vehicle.

### **Injuries Sustained**

Myofascial structures can be stretched; asymmetric increase in muscle tension can develop, causing altered joint movement; the facets can become affected, and posture altered.

MacNab did whiplash type research with monkeys and was able to describe these injuries: <sup>3</sup> slight muscle tears of the sternocleidomastoid ruptures; ruptures of the longus colli; retropharyngeal hematoma; esophageal hemorrhage; cervical sympathetic plexus lesion; tearing of the anterior longitudinal ligament.

Dunn and Blazer <sup>7</sup> concluded: "The most injurious head deflection in an acceleration injury is hyperextension. Even though sustained in low-velocity, rear-end collisions, this acceleration injury can

produce forces significant enough to produce musculoligamentous tears with resultant hemorrhage and even disk disruption and avulsion fractures of the vertebral bodies. In addition, the integrity of the apophyseal joints may be violated." They also conclude that in head-on collisions (flexion injuries): "In low- velocity flexion accidents, because the chin strikes the chest when the full range of physiologic flexion has been reached, minimal damage occurs."

### **Prognosis**

If present, degenerative changes should be noted as they may affect the prognosis. A claim of aggravation of a known pre-existing injury may occur after a low-speed impact.

Hohl<sup>4</sup> and Hohl and Hopp<sup>5</sup> found that complaints of interscapular pain, upper extremity pain, and numbness carried a poor prognosis, as did findings of a sharp cervical curve reversal, or restricted motion at one level on flexion/extension radiographs. Greenfield and Ilfeld<sup>15</sup> also noted that shoulder pain and arm and hand pain indicated slower progress toward recovery, and that if upper back pain and interscapular pain present, a longer and more intensive treatment program was needed.

Norris<sup>6</sup> found that the presence of objective neurological signs, significant neck stiffness and muscle spasm, and/or pre-existing degenerative changes adversely affected the outcome.

Hohl did a seven year follow-up after injury of patients without previous x-ray evidence of disc disease and found that 39 percent had developed degenerative disc disease at one or more disc levels since injury.<sup>4</sup>

### **Discussion**

We enjoy the thrill of driving bumper cars travelling at approximately 1-2 mph without a head restraint and without adequate seat belts at amusement parks. We like the feel of speedy roller coasters that whip our head and neck, and push our body to provide a sense of increased g forces. And if we should experience soreness or discomfort after these rides we have the ability to continue to go on and have fun the rest of the day. We relax and tell ourselves that it will go away. And so it could be with many of our patients involved in low-speed, low-impact collisions. The doctor must reinforce to the patient that it will go away. If the pain doesn't go away we must be able to discuss the mechanisms of injury and substantiate the presence of injury/illness.

Insurance companies and the general population have a skeptical attitude about these types of cases. Television commercials are polluting the juries viewpoint and the public is frustrated with the cost of insurance premiums. Ask people what they think of rear-end collisions, jury awards, and attorneys. They will respond with a different value than 10-15 years ago.

We need to make sure that patients are being sincere in their complaints. Credibility on the patient's side is very important. The issues of the low-dollar damage amount and low speed will come up. The doctor has a credibility image to maintain as well. Adjustors will look at the doctor's records and the treatment plan; insurance companies want to see a treatment plan. The important issues are the type of treatment, the cost of treatment and the length of time. The diagnosis is not indicative of the extent of the injury. Reports to the adjustor should supply the diagnosis and prognosis. At this point it does not appear that the insurance industry cares that chiropractic can substitute for more expensive care.

The key to documentation is showing that the patient is receiving benefit from the treatment (getting pain relief and improving functional capacity). Documentation must justify the treatment for the injury. It must show that treatment was actually rendered, and substantiate the injury by detailing the subjective and objective findings on the examination; justify treatment by showing decreases in pain and suffering; increasing recovery time; decreasing the likelihood of complications; increasing the function of the person during the recovery.

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