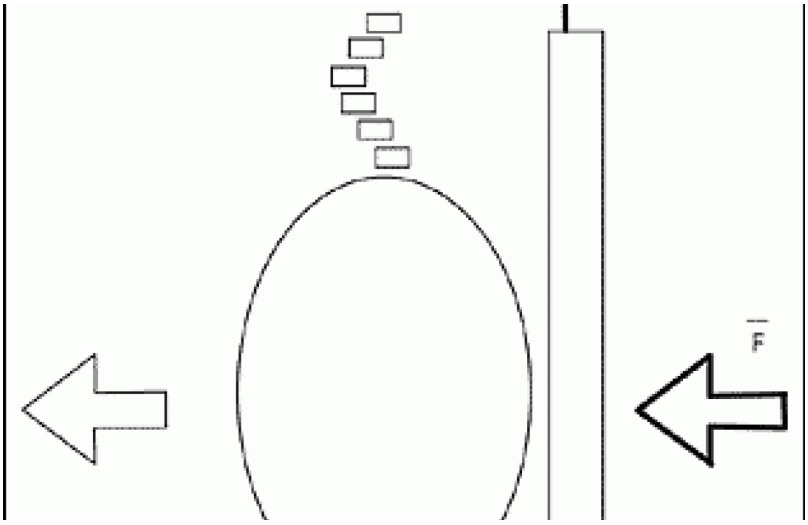
Dynamic Chiropractic



WHIPLASH / NECK PAIN

Understanding and Managing Whiplash-Associated Disorders

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Whiplash is a common injury, and whiplash-associated disorders are challenging for both clinicians and patients. Recently, much has been learned about the mechanisms of whiplash injury, and this may help us to better prevent and treat the associated disorders.

In everyday language, the term "whiplash" is usually used to describe a neck injury sustained in a low-speed motor vehicle accident, in which the injured person's vehicle is struck from behind. The injury has also been described as a "hyperflexion/hyperextension injury," and a "cervical acceleration/deceleration injury," on the assumption that these terms describe the motion of the neck at the time of impact. The pain and associated symptoms (such as dizziness and loss of concentration) that follow the accident have been termed "whiplash-associated disorders" (WAD). Many of the patients we encounter in practice are suffering from WAD, and many neck-pain patients may have a history of whiplash, even if they don't attribute their current pain to the condition.

Neck pain itself is a common complaint in developed countries. A survey in Norway showed that 34.4% of adults had experienced neck pain within the past year, and 13.8% had experienced pain that lasted more than six months.[1] Even among young adults, neck pain is quite common. In Finland, 17% of a cohort of high-school students ages 15 to 18 reported neck pain within the previous six months. Seven years later, among the same cohort, the prevalence of neck pain had risen to 28%.[2] In Sweden, 43% of adults (48% of women and 38% of men) had experienced neck pain, with 22% of women and 16% of men reporting pain of more than six months' duration. More than a quarter of these people with chronic neck pain reported having a whiplash injury.[3] Another study from Sweden showed that 17 years after the accident, 55% of patients reported current neck pain. This compares with 34% of women and 19% of men from a control group who had not experienced whiplash.[4] As WAD may be both severe and chronic, it is worthwhile to study the actual mechanisms of injury, to see if we cannot do a better job of prevention and treatment. We

also need to look critically at current treatments, to see which are most effective.

The Biomechanics of Whiplash

The whiplash injury is troublesome to study because it all happens so quickly - in just a fraction of a second, and involves complex motions of the various body parts. Using modern high-speed video and cinemaradiography, it is possible to record the kinematics (actual motions) of the skull and vertebrae. Furthermore, with accelerometers attached to the skulls and vertebrae of volunteers and cadavers, we can actually measure the accelerations (and therefore calculate the forces) affecting these body parts. Using these techniques, modern studies agree that the actual injury phase of whiplash is neither purely extension nor purely flexion of the neck; it is a combination of the two. Specifically, the upper cervical region goes into flexion, while the lower cervical region goes into hyperextension. The cervical vertebrae therefore form a letter "S," and this phase of the injury is now commonly referred to as the "S-phase."5 How does this curious deformation of the neck come about? The answer has to do with human biomechanics and the anatomy of car seats!

To understand the basic kinematics of whiplash, it is useful to think of the person's body as a golf ball, and the car seat as the head of a golf club. If we tap a golf ball with a club that has a flat head, like a putter, the golf ball rolls smoothly forward. On the other hand, it we hit the ball hard with a club that has an angled or wedged head, the ball lifts up into the air. If the backs of car seats were all perfectly upright, then in rear-end collisions, the struck vehicle and their passengers would all be pushed directly forward (Figure 1a). However, virtually all car seats are angled backward. Therefore, when the vehicle is struck, the car seat cuts under the passenger, just like a wedged golf club cutting under a ball, and drives the person upward and forward (Figure 1b). Research confirms that the more the car seat is angled backward, the more the person is propelled vertically in a rear-end collison.[6]

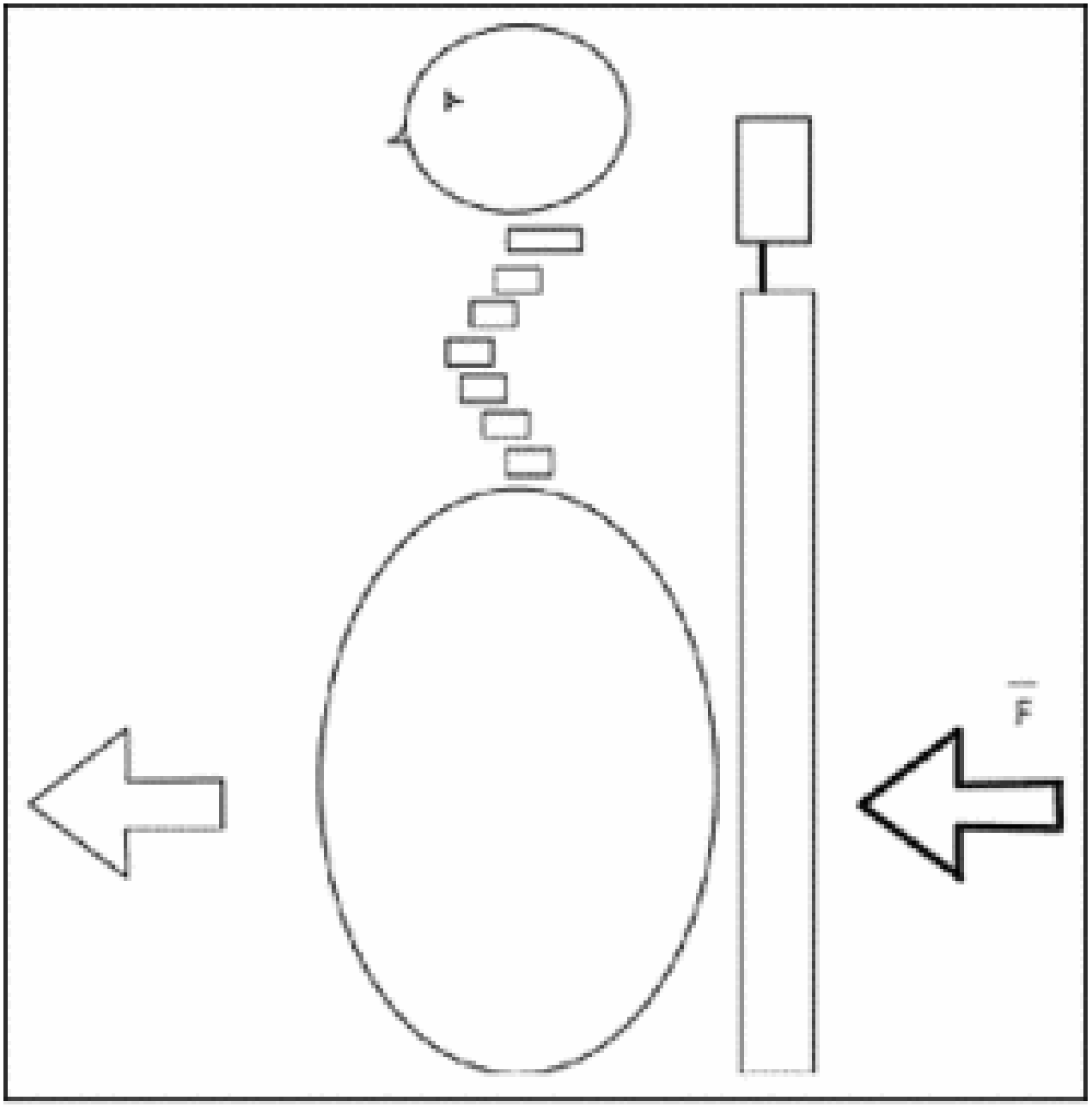

Figure 1a: With a completely vertical seat back, a rear impact tends to propel the rider directly forward.

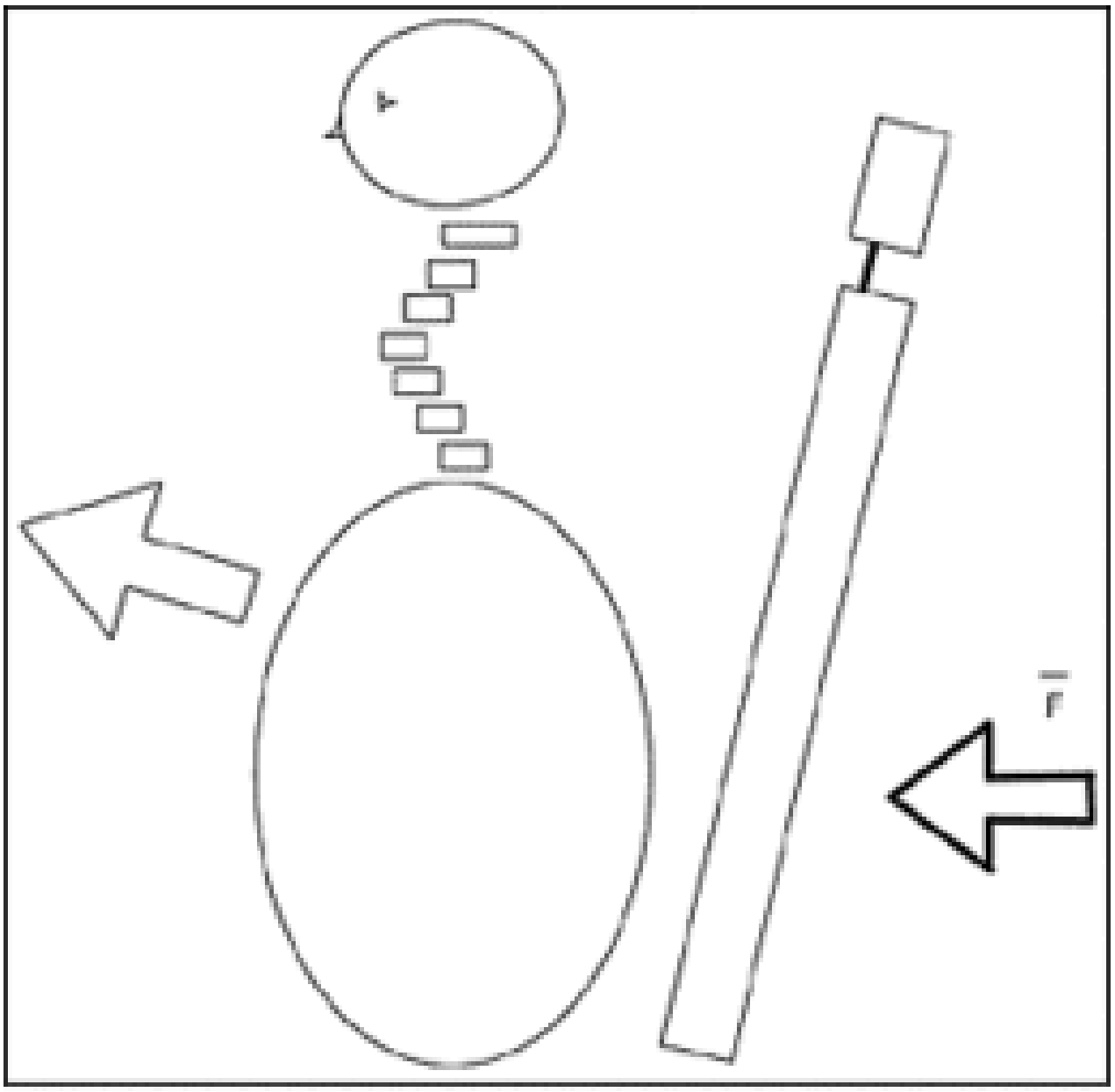

Figure 1b: With a seat back that leans backward, a rear impact propels the rider forward, but also exerts a vertical force. The greater the angulation of the seat back, the more the rider tends to be propelled vertically in a rear impact.

Now, the head and body are connected by the relatively weak and flexible neck. Because of the weight of the head, as the body is initially lifted up by the car seat, the head remains relatively stationary. This results in the neck being compressed between the head and body. Because of the anterior position of the center of gravity of the head, this tends to roll the head forward, bringing the upper cervical spine into flexion. At the same time, the compression of the neck accentuates the normal lordosis, so that the lower cervical spine moves into hyperextension (figure 2). Together, these events create the S phase. As the S curve is being generated, the torso and lowermost cervical vertebrae are also being pushed forward. Consequently, the very lowest cervical vertebrae are moving anteriorly with respect to the vertebrae immediately above them, and this creates a shearing force between the lower few cervical vertebrae.

Because of the compression of the neck, the lower cervical vertebrae cannot move as they normally

do. Rather than the facet joint surfaces gliding past each other, the anterior portions of the joints gap, while the posterior portions are pinched together. In experiments using both healthy volunteers and cadavers, this most often causes pinching of C5-6, and to a lesser extent, the C4-5 facet joints.[7] The shearing motion between vertebrae seems to be greatest at C5-6 and at C6-7.[8] All of this adds up to considerable stress on the facet joints (the joint capsules and the bony portion of the joint) in the lower cervical region. The S-phase of whiplash injury is finished within 100 milliseconds of impact.[9] In volunteers who are subjected to unexpected whiplash impacts, the activation of protective muscles does not even begin until 45 to 60 milliseconds; that is, until shear forces in the neck have already peaked.[10] Furthermore, computer models suggest that protective muscle guarding in the subject who is unaware of the impending impact does not significantly reduce forces on the vertebrae.[11] Following the S-phase, as the torso continues to move forward, the head rolls backward so that the entire cervical spine is in extension. Then, as the vehicle comes to a stop, the head is thrown forward, carrying the cervical spine into flexion. These last two phases - complete extension and complete flexion - last longer and are thus visible to the casual observer. However, the actual stresses on the spine during these phases are relatively mild, and the real damage has already been done during the S-phase.

From these observations of biomechanics, we would predict that the facet joints, rather than other tissues, might be especially important sources of pain in WAD, and that if we could reduce the special motions of the lower vertebrae that occur in whiplash accidents, we might reduce the occurrence and severity of WAD.

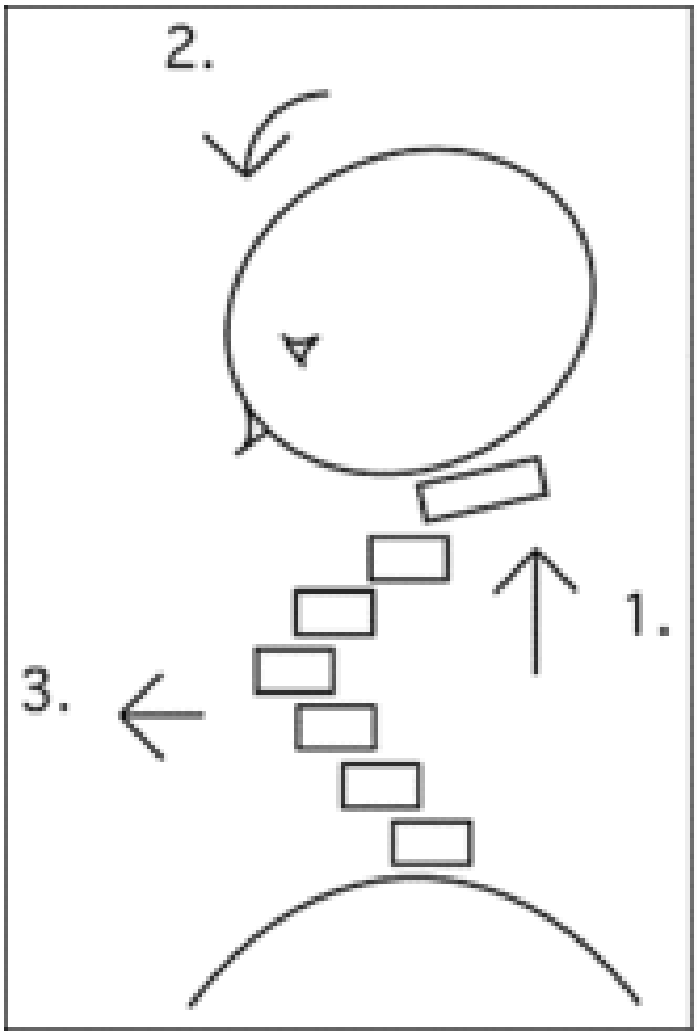

Figure 2: S-phase: With a rear impact, the torso is forced upward, compressing the neck against the head. (1.) Because of the anterior axis of rotation of the skull, this forces the skull to rotate anteriorly, (2.) which brings the upper cervical spine into flexion. As the torso and lower cervical vertebrae are propelled forward beneath the head, (3.) a shearing force is created in the mid-cervical region. These events collectively drive the neck into an S-shape, and place the greatest strain on the facet joints of the mid to lower cervical region.

Preventing WAD

Interestingly, WAD is more common and severe in women than in men. This is due, in part, to the fact that generally, women are smaller than men, and car seats, as they are currently designed, give more protection to men. In the past, many car seats were made of softer material, but the modern trend is toward firmer seats. This is more comfortable for long periods of driving, and may give more protection in high-impact collisions, but firm seats make riders more vulnerable to whiplash. This is especially so for smaller people (and therefore women, in general), since the firm seat transmits more force to the rider.[12] Experiments in volunteers and cadavers confirm that women's necks generally undergo greater displacements than men's necks in low-impact rear-end collisions.[7]

One would predict that having seats which are more upright, and having a smaller distance between the headrest and the head, would reduce injuries. Again, research confirms that having the headrest higher and moved forward reduces neck motion in collisions and reduces the severity of injuries.[6]

Treating WAD

Research from Australia confirms the importance of the facet joints as one source of pain in chronic WAD. In patients who continued to have neck pain as the dominant symptom more than three months after the accident, almost half reported relief with injection of anesthetic into the lower cervical facet joints.[13] In this study, the response to anesthetic was used as a diagnostic tool. The long-term treatment effects were not evaluated.

Of the various modalities used to treat chronic neck pain, only a few have been subjected to rigorous testing.

In general, the evidence seems to suggest that early active treatment of patients with whiplash injuries is beneficial, whereas immobilization and rest are less effective.[14]

A randomized controlled trial from Britain showed that patients given physical therapy (mobilization treatment and home exercises) had greater cervical mobility and less pain at the end of eight weeks than patients who were given soft cervical collars and advice to rest.[15] A very recent study from Germany confirms this, showing that patients who received physiotherapy and home exercises had less pain after six weeks than patients given cervical collars.[16]

More research pertains to neck pain in general, rather than to whiplash specifically. A study of 191 chronic neck pain patients in America showed that spinal manipulation alone, exercise alone, or a combination of spinal manipulation and exercise all had benefits for patients. However, as might be expected, overall the greatest improvements were seen in patients who had the combination of exercise and spinal manipulation.[17] These improvements were still apparent two years after the conclusion of treatment.[18]

In reviewing the evidence for manipulation and mobilization, a group from Canada and America reported there was good evidence that these therapies were effective for short-term relief of neck pain and headache, with a very low incidence of adverse effects from treatment.[19] A study from Japan has also shown short-term benefits for acupuncture therapy in the treatment of neck and

shoulder pain.[20]

It is not yet clear whether research concerning neck pain in general can be applied to WAD in particular. It may be that WAD is a very special type of neck pain, especially with respect to the involvement of the facet joints. Having said that, however, we can still make some useful generalizations to guide treatment:

1. In general, it seems that early active rehabilitation is more beneficial than rest and immobilization.
2. Having the patient perform exercises at home seems to be beneficial.
3. Therapies that move the cervical spine (mobilization and manipulation) seem to be beneficial.
4. Acupuncture may be beneficial.
5. A combination of approaches, such as home exercises and active therapies, is probably more effective than one approach alone.

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