A review of the literature refuting the concept of minor impact soft tissue injury

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CJ Centeno, M Freeman, WL Elkins. A review of the literature refuting the concept of minor impact soft tissue injury. *Pain Res Manage* 2005;10(2):71-74.

BACKGROUND: Minor impact soft tissue (MIST) is an insurance industry concept that seeks to identify late whiplash as a psychosocial phenomenon. However, the medical literature in this area has not been systematically reviewed since the Quebec Task Force's review in 1995.

OBJECTIVE: To review the medical literature which claims that late whiplash is an organic phenomenon causing significant disability.

METHODS: The medical literature was reviewed in a narrative format.

RESULTS: There are a significant number of studies which refute the MIST concept.

CONCLUSION: A review of the literature did not support the validity of MIST.

Key Words: Insurance; Late whiplash; Minor impact; MIST

Revue de la littérature réfutant le concept d'atteinte des tissus mous suite à un impact mineur

HISTORIQUE : L'atteinte des tissus mous résultant d'un impact mineur ou MIST (pour *minor impact soft tissue*) est un concept mis de l'avant par le monde des assurances qui tente d'imputer les conséquences tardives du coup de fouet cervical à un phénomène psychosocial. Par contre, la littérature médicale dans ce domaine n'a fait l'objet d'aucune recherche systématique depuis les travaux d'un groupe québécois en 1995.

OBJECTIF : Passer en revue la littérature médicale selon laquelle les répercussions tardives du coup de fouet cervical sont un phénomène organique à l'origine d'une invalidité significative.

MÉTHODE : Revue de la littérature médicale sous forme narrative.

RÉSULTATS : Un nombre significatif d'études réfutent le concept de MIST.

CONCLUSION : Une revue de la littérature n'a en rien appuyé la validité du concept de MIST.

In the mid-1990s, the United States automobile insurance industry launched a new concept in claims handling called MIST, an acronym for minor impact soft tissue. The theory behind this claims stance was that it is virtually impossible to sustain a permanent or serious injury in a low-damage car crash and, therefore, these claims should be handled differently. This new concept has expanded to almost all major American insurers, yet little has been published regarding its scientific validity. For many patients with objective physical examination findings but little automobile property damage, this policy has led to a loss of insurance coverage for their injuries.

THE MEDICAL LITERATURE IN SUPPORT OF MIST

Early studies (1) have suggested that the G forces involved in low-damage crashes were comparable to those commonly seen in normal, everyday activities. This concept was driven home by the Quebec Task Force in 1995 (2). The report seemed to demonstrate that whiplash was a short-lived and self-limited condition that did not require more than supportive care. In addition, other similar reports (3) suggested that late whiplash did not exist in countries where there is no legal system to recover damages. Moreover, more recent studies performed in Saskatchewan (4) suggested that when the ability to sue for pain and suffering was removed, the duration of the insurance claim for medical coverage was reduced. Based on this information, it would then seem reasonable for insurers to adopt the

MIST policy. However, because multimillion-dollar decisions rely on this policy, the validity of the research in support of MIST must be vetted.

Freeman et al (5) were the first to point out that many of the studies refuting the existence of late whiplash had very poor methodology. Freeman et al (6,7) also published a research critique of the Quebec Task Force and Saskatchewan studies, demonstrating that they also suffered from flaws in methodology. As a result, the conclusions of these studies were called into question. In light of this information, the foundation for the MIST concept needs further investigation.

THE LITERATURE LINKING LOW-DAMAGE, HIGH-ENERGY CRASHES TO SERIOUS INJURY

A major building block of the foundation for MIST relies on the concept that vehicle damage and occupant damage must be closely linked. In other words, there must be a linear relationship between how hard a vehicle is struck (ΔV or change in velocity) and serious injury rates. However, as a research question, this phenomenon is very difficult to study. Until recently, staged crashes were the only way any information regarding ΔV and injury rates could be gleaned. However, staged crashes are specifically designed not to injure the participants and are, therefore, a poor way to study injury rates.

Advancements in technology have provided ways for these questions to be answered in a real-world crash setting.

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Krafft et al (8) have studied the relationship between real-world ΔV , as measured by 'black boxes' installed inside vehicles, and chronic injuries. While one would expect a linear relationship, none was found. For instance, chronic injury rates at ΔV s of 5 km/h to 10 km/h were twice that of 10 km/h to 15 km/h! In addition, chronic injury rates at 15 km/h to 20 km/h were twice the rates seen at 20 km/h to 25 km/h ΔV s. These rates likely relate to the stiffness and elasticity of the vehicle and the complex interplay between seat design, occupant mass, occupant position and vehicle dynamics. In addition, Krafft et al also discovered a much higher Abbreviated Injury Scale 1 (whiplash-associated disorder II or whiplash-associated disorder III) chronic injury rate in the presence of a tow-hitch. This external factor hints at a list of complex kinematics that the MIST program does not take into account when determining injury risk. Finally, in the same study, Krafft et al also concluded that, "The two crashes which resulted in long-term disabling neck injuries had the highest peak acceleration (15 and 13 $\times g$), but not the highest change of velocity". This is of much concern for the MIST methodology, as it shows serious neck injury resulting from high peak accelerations in high-energy, but low-damage and low- ΔV settings. Brault et al (9) produced similar findings when investigating rear-end collisions. Their conclusions are also of concern for MIST:

"Objective clinical deficits consistent with whiplash associated disorders (WAD) were measured in both men and women subjects at both 4 km/h and 8 km/h. At 4 km/h, the duration of symptoms experienced by women was significantly longer when compared with that in men ($p < .05$). There were no significant differences in the presence and severity of WAD between men and women at 4 km/h and 8 km/h or in the duration of WAD at 8 km/h. There was also no significant difference in the presence, severity, and duration of WAD between 4 km/h and 8 km/h. No preimpact measures were predictive of WAD."

In summary, Brault et al concluded that trying to tie ΔV to injury rates does not work. Siegmund et al (10) echoed the same findings while trying to create a model of rear-end crash dynamics and long-term injury risk. Again, there was no connection between ΔV and injury risk. Finally, Davis (11) reached the same conclusion in a meta-analysis of the medical literature on ΔV and long-term injury risk.

Why is this uncoupling of crash damage and long-term injury rates occurring? Some clues can be found in studies presented at international congresses that show that vehicle stiffness has increased to reduce property damage in low-speed crashes (12). However, the vehicle is only one parameter. Much more attention has recently been paid to seat back design in rear-end crashes. Viano (13) has concluded that one reason whiplash injuries are increasing is that seats have been made stiffer to avoid rearward occupant ejection in a seat back failure. As seats are made stiffer, the shear forces (neck injury criterion) on the neck increase. In addition, a newer study (14) by the same author suggests that for women, a lower relative mass rather than seat back stiffness may play a role in serious neck injury at low speeds. The characteristics of head restraints are also likely involved (15).

Clearly, the lack of a direct link between ΔV and long-term Abbreviated Injury Scale 1 neck injury rates calls into question the validity of a no damage, no injury policy.

THE LITERATURE THAT DEFINES LATE WHIPLASH AS A SERIOUS MEDICAL CONDITION

If late whiplash is a short-term, mild muscle pull that should always resolve on its own with only supportive care, then the MIST policy would seem reasonable. However, if there were data showing that this injury is more serious, then MIST would be called into question.

The early medical literature for late whiplash is clearly supportive of a MIST policy. The focus of those studies was on a muscle strain and possibly a ligament sprain. Hence the term 'sprain-strain' was commonly used. Compared with other muscle strains such as a hamstring injury, whiplash seemed to have an excessively long recovery time that could only be explained by psychological problems (16-23). In addition, at the time, little was known about the central nervous system (CNS), and pain and spinal ligament injuries that did not require surgery.

However, in the past decade, much has been learned about what is injured in late-whiplash patients. As a result, the landscape has been significantly altered. What would previously be called a 'soft-tissue' injury has now been redefined into numerous injury categories.

Seminal studies by Twomey et al (24) and Taylor et al (25,26) demonstrated that serious spinal injuries could be detected with cadaver dissection. These patients had all died of other causes (eg, blunt abdominal trauma), yet many seemed to have very serious spinal injuries. These injuries included bleeding into the dorsal root ganglia, small fractures of the facet joints, bleeding into the facet joints and other injuries. While these insults could be easily detected on dissection, they could not be detected on advanced imaging.

In vitro studies by Grauer et al (27) and Panjabi et al (28,29) were also telling. In simulated low-speed, rear-end collisions, they demonstrated that facet joint shearing in the cervical spine as well as significant ligament stretch injury to the anterior longitudinal ligament and facet joint capsules occur. Other authors have now confirmed these findings and have added to the database of significant joint and ligament injuries that occur at low speeds (30,31). In addition, these findings have been confirmed in live volunteers in simulated low-speed crash tests (32). If the cervical facet joints were injured, then clinical studies would have to confirm that these joints were pain generators in a late-whiplash population. Indeed, numerous studies have now confirmed that when these joints are anesthetized and treated, both short-term and long-term relief result (33-36). In addition, in a reported double-blinded prevalence study (37), approximately 50% of patients with late whiplash were found with injured neck joints. More recently, central sensitization has been the focus of late-whiplash research. The above early studies demonstrating injury to the dorsal root ganglion, as well as crash research by Svensson et al (38,39), Ortengren et al (40) and Eichberger et al (41) showing injury to the same structure, has moved researchers to take a closer look at neurological injury. It has been noted by numerous researchers that late-whiplash patients have different sensory thresholds than normal controls (42-47). These patients show increased sensitivity to a variety of stimuli including pressure, light vibration, and heat and cold not only in the neck but also in body areas remote to the site of pain such as the front of the shin. This means that they feel things differently than someone with a normal sensory system. It is important to note that in the patients who fail to recover, these

sensory changes have been shown to be present from very soon after injury. As outlined above, the prevailing opinion is that this is due to sensitization of the CNS. For instance, recent research has correlated elevated levels of a protein only released in CNS injury with more severely injured whiplash patients (48). However, more surprising is that serum muscle injury markers are not elevated in whiplash patients, indicating that the muscle strain part of the whiplash theory espoused early on is likely not valid (49).

Finally, as shown above, investigators over the past decade have reported that serious ligament injury is likely one cause of late-whiplash injury. Magnetic resonance imaging indicators of upper cervical ligament injuries in the alar, transverse ligament, posterior atlanto-occipital membrane and tectorial membranes have been found in late-whiplash patients but not in controls (50-53). In addition, significant lower cervical ligament injury has also been reported by multiple authors both in real-world imaging studies and in vitro cadaver studies (30,54-59).

From all of the above evidence, it can be seen that, at least in some patients, whiplash is a complex, multifaceted condition that requires a suitable classification system to address these complexities.

LONG-TERM PROGNOSIS FOR LATE-WHIPLASH INJURY

If late whiplash is more than a muscle pull or mild sprain, then are these problems minor 'soft-tissue' injuries or do they have a major functional impact?

Berglund et al (60) have looked at this issue in a large epidemiological study where several hundred patients who sought specialist care for a rear-end crash were compared with several thousand people not exposed to such a crash. Seven years after the crash, there was a 160% to 370% increased risk for headache, thoracic and low back pain, fatigue, sleep disturbances and ill health for those who were in a rear-end crash. A similar type of investigation (61) found a threefold increase in the risk for neck and shoulder pain seven years after a rear-end crash exposure. In addition, Squires et al (62) reported on a group that was followed for 15.5 years in which over 70% of patients continued to report symptoms related to the original crash at the end of the study. Between years 10 and 15.5, 18% had improved, while 28% had worsened and 54% had stayed the same. Finally, Bunketorp et al (63) conducted a similar investigation 17 years after a crash. They found that when patients who sought specialty care for injuries reported in an emergency room were compared with patients also seen in the emergency room but with no motor vehicle crash-related complaints, the disability rate in the injury group was 30% to 35%, while the noninjury group reported an injury rate of only 6%.

IS MIST STILL SCIENTIFICALLY VIABLE?

While many authors have published studies that would seem to support the MIST hypothesis, the vast majority of work published in the past 10 years would not support MIST. Assuming that an insurer must take the position that the policyholder must at all times be given the benefit of the doubt, the MIST program does not have overwhelming scientific support. It is time to retire MIST in favour of a research-based severity index approach that allows insurers to better allocate resources.

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