



Professional issue

Content not quantity is a better measure of muscle degeneration in whiplash

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ABSTRACT

Whiplash associated disorder (WAD) represents an enormous economic, social and personal burden. Five out of 10 people with WAD never fully recover and up to 25% continue to have moderate to severe pain-related disability. Unfortunately, clear and definitive reasons as to why half of individuals with WAD recover uneventfully and the other half do not, remain elusive. Identifying the factors that can reliably predict outcome holds considerable importance for not only WAD, but arguably for other acute musculoskeletal traumas. The precise pathology present in WAD has been controversial and often biased by outdated models. Fortunately, a combination of new measurement technology that illuminates pain processing, physical and social functioning and post-traumatic stress responses (and possibly markers of altered muscle size/shape/physiology) is providing a clearer picture of the multisystem pathophysiology in individuals with persistent WAD. The aim of this professional issues paper is to illuminate the clinical and research communities with regards to the growing body of knowledge for determining the trajectory of a patient with whiplash.

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1. Introduction

Optimistic expectations of the Western World might lead members of modern society to believe that whiplash injuries from a motor vehicle collision (MVC) are unlikely to produce chronic pain related disability, raising questions as to whether it reasonable to think a simple, often low-speed (<10–15 mph), rear-end collision can cause injury? Contrary to such optimistic expectations, third party insurance (TPI) claims related to whiplash in the United Kingdom (UK), for example, have risen by 40% since 2006 (Actuaries, 2012). In 2011 the increase in TPI claims led to a £440 m increase in costs to UK insurers, resulting in a total cost of £2 billion (Actuaries, 2012). These emerging patterns have led many to question the validity of persistent whiplash related pain and disability. Recent UK government bills have reinforced the urgency of understanding the broad context of whiplash:

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“It is difficult to diagnose whiplash injuries objectively and this has deterred insurers from defending claims in court. We recommend that the bar to receiving compensation in whiplash cases should be raised. If the number of whiplash claims does not fall significantly as a result there would, in our view, be a strong case to consider primary legislation to require objective evidence of a whiplash injury...before compensation was paid” (House of Commons Transport Committee, 2011).

The Association of British Insurers (2012) opines that injury is virtually impossible to disprove, making whiplash the ‘fraud’ of choice for those looking to make away with easy money through illicit compensation schemes. Although there is an obvious and growing concern of a compensation culture related to whiplash, it is not clear that a relationship between compensation-related factors and health truly exists (Spearing and Connelly, 2011). Whilst fraud may exist, clinical research suggests that up to 50% of patients will never fully recover from a whiplash injury following a MVC (Carroll et al., 2008). Such data make it difficult to readily refute an injury model for Whiplash associated disorder (WAD). At

the core of this complex and wide-reaching matter is a simple question: does injury following MVC exist?

To answer this question, clear, consistent and accurate measures of injury are required. Unfortunately, measuring whiplash injury is no easy feat. Meaningful identification of salient pathology with existing imaging technologies is not readily available (Elliott et al., 2009a, 2009b; Sterling et al., 2011). There are however several aetiological, physiological and psychological processes that would appear to play a role in the initiation and maintenance of long-term symptoms following whiplash trauma (Sterling et al., 2011). The relationships and interactions between these processes are not totally clear but it is imperative that future research elucidates the mechanisms underlying these processes in order to provide a foundation for more informed assessment and management strategies. Given the multi-factorial, multi-stakeholder associations of whiplash, the authors propose that it is absolutely critical that accurate and quantifiable measures of injury – and the response to the injurious event – be explored and developed.

2. Why is the pathology missed?

Although controversial, current evidence suggests the presence of a peripheral lesion in some individuals following whiplash (Curatolo et al., 2011). There also exists evidence that a peripheral lesion may not be required for the genesis (and maintenance) of clinical signs/symptoms (Sterling et al., 2011). Further complicating the issue is the widely accepted position that radiological findings are inconsistently associated with poor recovery (Pettersson et al., 1994, 1997; Borchgrevink et al., 1997; Pfirrmann et al., 2001; Myran et al., 2008; Matsumoto et al., 2010; Myran et al., 2011; Ulbrich et al., 2012). In contrast, a recent set of investigations into the degeneration of muscular tissues in whiplash provides preliminary evidence to suggest otherwise (Elliott et al., 2006, 2008a, 2008b, 2009a, 2010, 2011; Elliott, 2011).

Muscle fatty infiltrates on magnetic resonance imaging (MRI) develop soon after the whiplash event (between 4-weeks and 3-months), but only in those with higher initial pain levels and a subsequent post-traumatic stress response (PTSD) (Elliott et al., 2011). While the genesis of such muscle changes and their ultimate influence on recovery remains largely unknown, the early presence of structural muscle degeneration in tandem with well-established physical and psychological factors and their role in recovery (or non-recovery) from whiplash injury should not be under-estimated (Elliott, 2011; Sterling et al., 2011, 2012).

3. Why does this matter?

As stated, up to 50% of people who experience a MVC will never fully recover (Carroll et al., 2008), and approximately 25% will remain moderately to severely disabled in the long-term (Sterling et al., 2003a, 2003b, 2003c, 2005, 2006; Sterling, 2004; Carroll et al., 2008; Walton et al., 2009). The early (4 weeks post-injury) presence of sensory and motor deficits as well as psychological distress (PTSD) in the 25% with moderate to severe pain and disability is strongly associated with poor functional recovery in the long-term (Sterling et al., 2006).

Despite this available evidence, the prevailing media-driven opinion in the UK (and certainly other western cultures) remains that whiplash is a fraudulent 'crash for cash' condition. Complimentary to such assertions, some authors of recent peer-reviewed works using serial MRI measures of muscle degeneration (Matsumoto et al., 2012; Ulbrich et al., 2012) have appeared to excuse the available literature in this area and as such, demonstrate a lack of current understanding of the neurophysiological and psychological processes associated with the transition from acute

to chronic pain. Failing to acknowledge the available evidence could result in an ongoing worldwide public mind-set that *people claiming whiplash injuries should not be entitled to compensation since there is no objective evidence that they have suffered injury.*

4. Example of 'outdated' muscle imaging in whiplash

First, the authors wish to commend Matsumoto and colleagues on their work (Matsumoto et al., 2012). Completing a 10-year follow-up of subjects with whiplash injury secondary to a MVC is not an easy endeavor. However, their conclusion that whiplash injury is not associated with symptomatic atrophy of the posterior cervical muscles in the long term is tenuous and not fully supported by their findings. Whilst Matsumoto et al. (2012) acknowledged the limitations of small sample size, they have omitted a plethora of available evidence (from 2003 on) highlighting risk factors for poor functional recovery following whiplash injury. Such evidence has greatly increased existing knowledge regarding the complex clinical presentation of patients that are at risk for transitioning from acute to chronic pain. Despite this available evidence, Matsumoto et al. (2012) instead performed a binomial transformation of subjective self-report data on neck pain, shoulder stiffness, headache, arm pain and/or numbness. In short, there was no attempt (nor mention of need) to categorize these patients with respect to varying levels of pain and disability.

Second, the MRI measure of muscle cross-sectional area (CSA, which is really a volume) and comparisons between Gradient Echo (GRE) Imaging (initial set of scans) with T2-weighted scans (10 year follow-up) detailed in the Matsumoto et al. study (2012) is not consistent with previous studies using anatomical T1-weighted scans for measuring neck muscle morphometry (Elliott et al., 2008a). As suggested, a fat suppressed acquisition (and/or an inversion sequence, such as a Short T1 Inversion Recovery (STIR)) is possible, but the T1 of fat has to be assumed, which may vary depending on the evolution of fat infiltration (Bydder et al., 1985).

Third, the measures of CSA should (going forward) be accurately categorized as a 3D volume of the entire muscle as 3D acquisition methods have evolved and are not as sensitive to the radio frequency slice profile as is 2D imaging. As such, the reported 'CSA' measures in this study (and admittedly others – Elliott et al., 2008a)) may have partial volumes. Another issue remains the lack of reporting on how the slices were aligned in plane. Not doing

Table 1

Standardized clinical self-report outcome measures that should be used in whiplash.

Clinical self-report measures
Neck Disability Index (NDI)
The NDI is a 10-item validated questionnaire (Vernon and Mior, 1991) that has been widely used in studies of whiplash (Sterling et al., 2005, 2006; Elliott et al., 2006; Elliott et al., 2010; Sterling et al., 2012) and can be scored as a percentage ($x/100$). Higher scores equal more pain and disability.
Impact Events Scale (IES)
The IES (Horowitz et al., 1979) is a 15-item questionnaire measuring present stress related to a particular event. The IES has been validated in studies investigating emotional responses to acute trauma (Karlehagen et al., 1993; Sterling et al., 2003b) and shown to be predictive of poor outcome in the long-term following whiplash (Sterling et al., 2006; Sterling et al., 2012).
Tampa Scale of Kinesophobia (TSK)
The TSK is a reliable and valid 17-item self-report measure of fear of re-injury due to movement (kinesophobia) (Kori et al., 1990). Clinicians should feel confident in using the TSK-11 with people with neck pain, especially of traumatic origin and longer duration (>6 months) (Walton and Elliott, 2013)
Cold pain thresholds and pain intensity ratings
A pain intensity rating of >5 provides for a positive likelihood ratio of 8.44, suggesting that if this value is reported, clinicians could be suspicious of the presence of cold hyperalgesia (Maxwell and Sterling, 2012)

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