Advancing imaging technologies for patients with spinal pain: with a focus on whiplash injury

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Abstract

BACKGROUND CONTEXT: Radiological observations of soft-tissue changes that may relate to clinical symptoms in patients with traumatic and non-traumatic spinal disorders are highly controversial. Studies are often of poor quality and findings are inconsistent. A plethora of evidence suggests some pathoanatomical findings from traditional imaging applications are common in asymptomatic participants across the life span, which further questions the diagnostic, prognostic, and theranostic value of traditional imaging. Although we do not dispute the limited evidence for the clinical importance of most imaging findings, we contend that the disparate findings across studies may in part be due to limitations in the approaches used in assessment and analysis of imaging findings.

PURPOSE: This clinical commentary aimed to (1) briefly detail available imaging guidelines, (2) detail research-based evidence around the clinical use of findings from advanced, but available, imaging applications (eg, fat and water magnetic resonance imaging and magnetization transfer imaging), and (3) introduce how evolving imaging technologies may improve our mechanistic understanding of pain and disability, leading to improved treatments and outcomes.

STUDY DESIGN/SETTING: A non-systematic review of the literature is carried out.

METHODS: A narrative summary (including studies from the authors' own work in whiplash injuries) of the available literature is provided.

RESULTS: An emerging body of evidence suggests that the combination of existing imaging sequences or the use of developing imaging technologies in tandem with a good clinical assessment of modifiable risk factors may provide important diagnostic information toward the exploration and development of more informed and effective treatment options for some patients with traumatic neck pain.

CONCLUSIONS: Advancing imaging technologies may help to explain the seemingly disconnected spectrum of biopsychosocial signs and symptoms of traumatic neck pain. © 2017 Elsevier Inc. All rights reserved.

Keywords: Biopsychosocial; Imaging; Low back pain; MRI; Neck pain; Whiplash

Introduction

With an increasingly aging population, health-care spending is expected to increase dramatically [1,2]. In the United States, dollars spent on health care is greater than any other country in the world [2], with the largest increase in spending between 1996 and 2013 for musculoskeletal disorders such as neck and low back pain [2]. Despite the rising expenditures, little appreciable change in neck and low back pain prevalence has occurred either in the United States or across the globe [3–6]. Efforts to control spending and improve outcomes must consider the expense associated with delivery of interventions and diagnostic tests with little evidential support. Unnecessary imaging for patients with low back and neck pain has rightly received wide criticism [7–9], and triggered important work examining behaviors in physicians (and patients), aimed at reducing imaging overuse [8–10].

Routine use of early diagnostic imaging tests is challenged for multiple reasons. Numerous studies demonstrate abnormal or variant morphology of the cervical [11] and lumbar [9,12–16] spines of asymptomatic participants (false positives) [17], and other studies highlight the lack of imaging findings in some patients injured from whiplash [18–21] or suffering from low back pain (potential false negatives) [8,13,22]. Few studies have investigated the longitudinal predictive value of imaging findings in the lumbar [23] and cervical spine [18,21], and most importantly, there is currently little evidence that magnetic resonance imaging (MRI) findings help identify those who respond best to specific interventions [24].

On the other hand, although some imaging findings are common in those without pain, several findings (eg, disc degeneration, Modic change, annular tear, disc herniation) have been shown to be substantially more common in those with low back pain [17,25] and traumatic neck pain (eg, muscle fatty infiltrates [MFIs]) [26–32] than those without. Such discrepant findings have created a clinical (and research) dilemma that we believe is due partly to a lack of high-quality studies and many perhaps misguided attempts to investigate the usefulness of imaging in understanding spinal pathology.

In this clinical commentary, we draw from existing and emerging research to (1) briefly detail available imaging guidelines, (2) present research-based evidence around the potential clinical use of findings from advanced but accessible imaging applications (eg, fat and water MRI and magnetization transfer imaging [MTI]), and (3) introduce evolving imaging technologies that may improve our mechanistic understanding of pain and disability, ultimately leading to improved treatment outcomes.

Imaging guidelines

We do not dispute the universal guideline recommendations to avoid routine, non-indicated imaging for spinal pain, and we further endorse that routine imaging should not be conducted once the patient has been medically screened and determined to not have serious pathology. Furthermore, we agree with Chou et al. [14] who state

> …addressing inefficiencies in diagnostic testing could minimize potential harms to patients and have a large effect on use of resources by reducing both direct and downstream costs. In this area, more testing does not equate to better care. Implementing a selective approach to [spinal imaging] as suggested by the American College of Physicians and American Pain Society guideline on low back pain, would provide better care to patients, improve outcomes, and reduce costs. [page 181]

The primary evidence-derived imaging guideline for healthcare providers in the United States is the American College of Radiology Appropriateness Criteria (ACR-AC). Relevant to this paper are the ACR-AC clinical conditions of (1) Chronic Neck Pain [33], (2) Suspected Spine Trauma [34], and (c) Low Back Pain [35]. Readers are encouraged to revisit the "clinical conditions" and subcategories (or variants) of the ACR-AC guidelines detailed above.

The authors support the value of these well-established and expert-derived guidelines that imaging is appropriately not recommended for the majority of patients with spinal pain. However, despite the proposed benefits of following the guidelines (cost-savings, reductions in exposure to ionizing radiation, avoiding the identification of pathology that may simply represent normal variants, and potentially misinforming clinical decision making), adherence to guidelines is quite variable [36–38], and it is largely unknown if adherence results in improved outcomes. Furthermore, there remains a lack of a gold standard quantitative metric for diagnosing low back and neck pain. Without a gold standard against which to compare, it is impossible to investigate whether diagnosis improves outcomes in our current landscape of care. Secondly, the presence of pathology in some people with low back and neck pain should not be dismissed as a normal variant on grounds they are also present in some without these conditions. Accordingly, there is an urgent need to perform high quality prospective imaging studies with quantitative measures using existing (T1-, T2-weighting) and other developed, *but not an exhaustive list of*, techniques (fat and water MRI or MTI) to better understand which imaging findings are and are not important.

A potential outcome of ongoing research and development could be that emerging technologies and research findings afford the opportunity to interrogate our own clinical instincts when managing patients with more complex, and seemingly unexplainable, signs and symptoms. Moreover, such knowledge would provide for the judicious use of carefully selected quantitative imaging sequences in tandem with known psychosocial risk factors that improve diagnostics, and hopefully improve outcomes.