Subaxial cervical spine injury classification system: is it most appropriate for classifying cervical injury?

The cervical spine injury represents a potential devastating disease with 6% associated in-hospital mortality (Jain et al., 2015). Neurological deterioration ranging from complete spinal cord injury (SCI) to incomplete SCI or single radiculopathy are potential consequences of the blunt trauma over this region. The subaxial cervical spine accounts the vast majority of cervical injuries, making up two thirds of all cervical fractures (Alday, 1996). Few classifications (Holdsworth, 1970; White et al., 1975; Allen et al., 1982; Denis, 1984; Vaccaro et al., 2007) have been proposed to describe injuries of the cervical spine for several reasons. First, to delineate the best treatment in each case; second, to determine an accurate neurological prognosis, and third, to establish a standard way to communicate and describe specific characteristics of cervical injuries patterns. Classical systems are primarily descriptive and no single system has gained widespread use, largely because of restrictions in clinical relevance and its complexity.

Classical systems: Allen classification has been commonly used over the past two decades. This system is based on a clinical review of 165 patients with blunt cervical trauma (Allen et al., 1982). Each lower cervical injury is divided into 6 categories of injury, which truly describe the attitude of the cervical spine at the time of injury and the dominant force vectors – compressive flexion, vertical compression, distractive flexion, compressive extension, distractive extension and lateral flexion. Distractive flexion injuries were the most common in these 165 patients. Within each category, a series of injury are described, ranging from mild to severe, which are related at the same time with neurological impairment. However, this classification does not allow to make a comparison, in terms of neurological outcome, between different categories of injury mechanisms. Allen system also fails to explain clearly some important force vectors, such as rotation and their implication in spine stability. Neurological status is not included as a criteria of this structural and mechanistic classification. Those individuals with SCI without radiological abnormalities (SCIWORA) are underrepresented and may lead to mistakes in terms of management and predicting clinical outcome, despite the potential disability in this subgroup of patients.

White and Panjabi (1975) elucidated that similar injury mechanisms can produce different injury patterns due to the complexity of the specific forces, moments and positions. They described a complex point-based system to assess cervical spine stability. Not only clinical data, but also in vitro biomechanics testing are the basis of this classification. A street test is also required, which runs against the simplicity and applicability in critical patients. This system also fails in terms of validity and inter observer reliability.

Two-column and three-column (Holdsworth, 1970; Denis, 1984) systems may provide more simplicity and a better understanding of the common injury patterns seen in the lower cervical spine. Holds worth in his two column model, postulated that the integrity of the posterior bony elements and the posterior ligamentous complex is the major determinant of stability. However, this scheme was insufficient to predict the presence of an unstable subset of compression fractures. Dennis modified the two column theory into a three column system. He defined a middle column, consisting the posterior longitudinal ligament and the posterior third of the vertebral body. The term of "unstable fracture" was coined when the middle column and one of the remaining columns – anterior or posterior – were injured. In spite of being primarily described to elucidate different patterns of fracture in thoracic and lumbar spine, its use has commonly widespread over scientific community. Lower cervical biomechanics differ so much with lumbar and dorsal spine, as C-spine implies wider range of mobility, lesser fixation and a different distribution of articular facets. Denis model (two-column) widely used, is an oversimplification that fails to incorporate the biomechanics importance of the spinal ligaments, which are also linked to degree of SCI (Martinez-Perez et al., 2014b). Moreover, some specific patterns, such as "chance fracture", is underreported in the cervical spine. So, in our opinion, resorting to these nomenclature to define some cervical fractures may result misleading (Alday, 1996).

Changes in paradigm: from the structure to the function: All of these “classical” system mentioned above are based on the mechanism of injury extracted from plain radiographs or CT scans, ignoring the contribution of ligaments to stability and the role of MRI in the stratification (Martinez-Perez et al., 2014a). The role of neurological impairment to determine the prognosis has been clearly demonstrated in previous works and represents an important indicator of severity of cervical spine injury (Miyanji et al., 2007). Moreover, neurological status may be the single most influential factor to indicate conservative or surgical management. Its widely accepted that incomplete neurological injuries requires surgical decompressive procedure, even in the case of absence of frank structural instability. Then, some authors considere that neurological impairment should be include in new systems of classification in order to give them the possibility to help to the surgeon in decision making (Moore et al., 2006; Vaccaro et al., 2007).

The need for a practical lower cervical spine classification system directly linked to a clinical decision-making algorithm prompted the Spine Trauma Study Group to develop the Subaxial Cervical Spine Injury Classification (SLIC) system (Vaccaro et al., 2007). This is a severity scale that attempts to provide a utilitarian classification framework to the clinician and surgeon involved in the treatment of sub-axial injuries. Instead of building the system on an inferred mechanism, it is based on 3 components of injury (mechanism/morphology, integrity of the posterior ligamentous complex and neurological status of the patients, Table 1) which, by consensus, represent major and largely independent determinants of prognosis and management. The total number of points is calculated for each cervical fracture or dislocation based on these three major categories, an the final score is linked to an algorithm to help guide management: injuries with a SLIC score of 4 or less are managed conservatively, fractures with a score of 6 or more are surgically operated, and injuries with a score of 5 may be managed either with surgery or non operatively at the surgeon’s discretion (Dvorak et al., 2007). In this way, the SLIC severity scale is the first sub-axial trauma classification system to abandon mechanism and anatomy characterized by other systems in favor of injury morphology and clinical status. However, this system lacks the attention toward the level of injury, which also can determine either the prognosis, as the surgical approach in each case. Other limitation of the mentioned system is the current use in neurosurgical community, lower than older classifications (Chhabra et al., 2015).
Despite of being far from an ideal classification for cervical trauma, by building the system on injury patterns less severe to more severe, the SLIC severity scale helps to objectify the optimal management in each case. Further studies have shown that SLIC scale exhibits excellent validity and inter observer reliability, unlike other classifications (Vaccaro et al., 2007; Patel et al., 2010; Aarabi et al., 2013).

**Conclusion:** “Classical” cervical injury classifications are characterized for its complexity, low applicability, and its uselessness in guiding therapeutic options. New schemes, as SLIC system, includes determinant factors in prognosis, such as neurological impairment. It will hopefully facilitate the development of evidence-based guidelines that may influence other aspects of the therapeutic decision-making process (e.g., which operative approach is most appropriate for a particular injury). We certainly believe its accuracy and reproducibility will increase over time as surgeons become more familiar with the protocol.

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