Classification of acute subaxial cervical spine injury

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Abstract

Study Design

Literature review

Objective

The aim of this thesis is to compare the main classification systems available for classifying acute subaxial cervical spinal injury and compare their relative strengths and weaknesses, especially in their ability to guide treatment and predict prognosis.

Methods

A PICO question was formulated and used to select search terms. The search terms were used to search the online database Pubmed/Medline for English language review articles less than 10 years old. These were evaluated based on their abstracts and articles relevant to the PICO question were selected. The final 9 articles were studied and their bibliographies were searched for relevant secondary articles.

Results

Five main classification systems for acute subaxial cervical trauma were found (Holdsworth's classification, Allen's classification, Harris' classification, the subaxial cervical spine injury classification system (SLIC) and the cervical spine injury severity score (CSISS)).

Conclusion

By comparing the classification systems, it is evident that older classification systems (Holdsworth, Allen et al and Harris et al) have focused on the mechanisms of injury while newer classification systems (Vaccaro et al, Moore et al) have discarded this in favour of radiological findings and, in the case of Vaccaro et al, neurologic status. Comparisons of the classification systems show that there are clear advantages to the system presented by Vaccaro et al (SLIC scale) compared to previous systems because it may be used to guide treatment, however it has lower reliability and validity compared to the Allen and Harris systems. The CSISS has a higher interrater and intrarater reliability than the SLIC scale but is not suitable for guiding treatment for injuries with scores <7 and does not include neurological status. There is a need for further study and evaluation of the SLIC system to ascertain its true reliability in a clinical setting.

Introduction

The aim of this thesis is to compare the main classification systems available for classifying acute subaxial cervical spinal injury and compare their relative strengths and weaknesses, especially in their ability to predict choice of treatment and prognosis. It is also of interest to present the historic development of the classification systems.

Anatomy

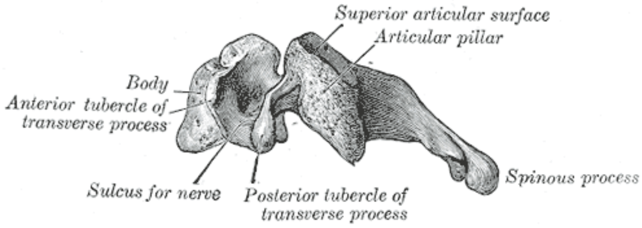


Image 1. Side view of a typical cervical vertebra(13).

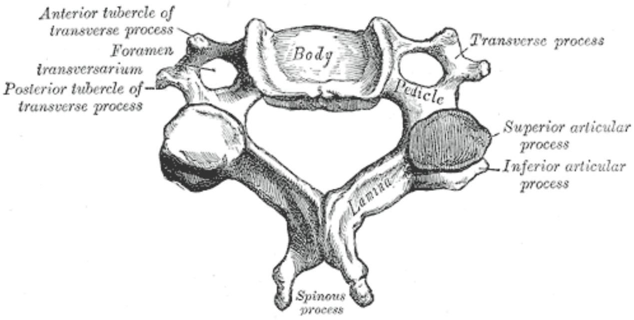


Image 2. Cervical vertebra(13).

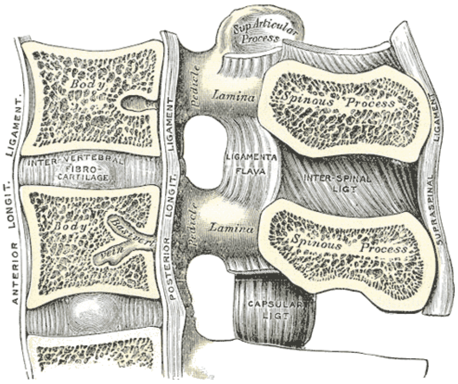
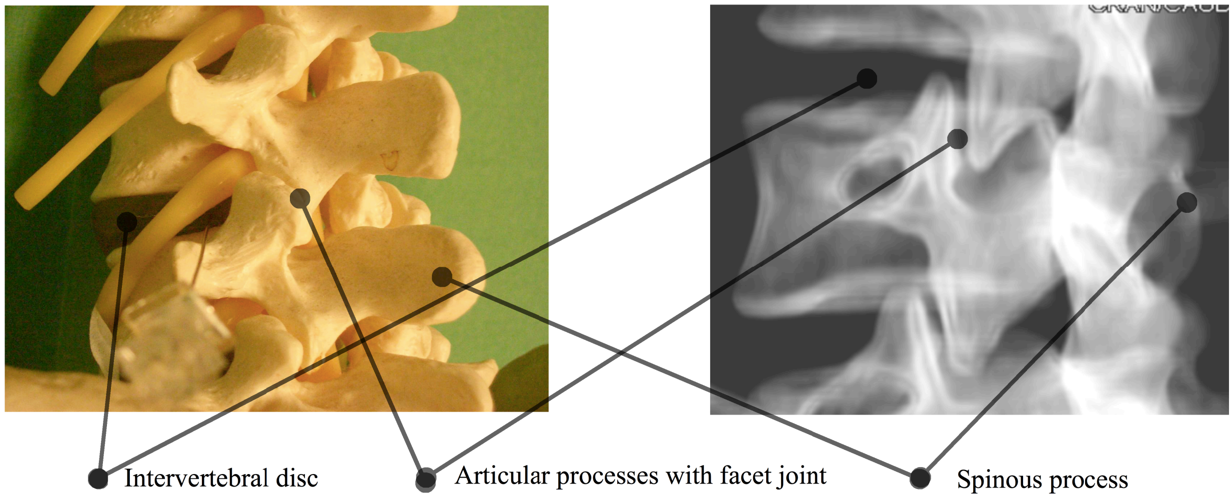


Image 3. Median sagittal section of two lumbar vertebrae and their ligaments(13).

The subaxial cervical spine consists of the vertebrae C3 – C7. Each vertebra consists of a body and an arch that form the neural canal. Posteriorly from the arch there is a spinous process (see image 1). A vertebra articulates with the subjacent and superjacent vertebrae at the inferior and superior articular processes respectively (see images 4 and 5). The transverse processes consist of an anterior and a posterior bar that fuse and produce the foramen transversarium that encloses the vertebral artery on either side (see image 2). Between vertebral bodies there is an intervertebral disc consisting of an outer annulus fibrosus and an inner nucleus pulposus. The vertebral bodies are supported anteriorly by the anterior longitudinal ligament and posteriorly by the posterior longitudinal ligament. The lamina are connected by the figamenta flava, while the spinous processes are connected by the intraspinous and supraspinous ligaments (see image 3).



Images 4 and 5. Lumbal vertebrae. Courtesy P. H. Nakstad

Prevalence

Among patients with blunt trauma who undergo imaging studies, the prevalence of cervical spine injury is 2-3%. This increases with age and is 4,5% for patients >65 years old. The absolute number of injuries is highest for young adults (aged 15-45 years)(2).

Definitions

Anterior ligament(ous) complex: intervertebral disc and the anterior and posterior longitudinal ligaments.

Articular pillar: The fusion of the superior and inferior articular processes to form one mass.

Posterior ligament(ous) complex: supraspinous and intraspinous ligaments, the capsules of the posterolateral joints and the ligamentum flavum(3).

Methods

Initially, a PICO question was formulated:

"Among the adult population with subaxial cervical spine injury, which subaxial cervical spine injury classification system will best predict choice of treatment and prognosis?"

Based on the PICO question, search terms were formulated and the online database Pubmed/Medline was searched for articles containing the following search terms:

> "classification AND cervical AND (spine OR spinal) AND (injury OR trauma)"

Initially, 739 articles were found, of which 386 where from the last 10 years. The search was further narrowed to only review articles and 59 were found. Of these, 12 where excluded because they were not in the English language. The articles were evaluated based on their abstracts and articles relevant to the PICO question were selected. Of the final 13 articles, 4 were not available either electronically or in printed form from the university library at the University of Oslo and could not be studied further. The final 9 articles were studied and their bibliographies were searched for relevant secondary articles.

Results

Five main classification systems for acute subaxial cervical trauma were found(3)(4)(5)(1)(6). All classification systems have been presented below.

Holdsworth's classification

Sir Frank Holdsworth published his classification(3) in 1970, "based on his study of over 1000 pasients with traumatic paraplegia or quadriplegia and on the study of very many more fractures and dislocations of the spine not associated with damage to the central nervous system"(3). The classification was for spinal trauma in general and therefore also included cervical spinal injuries.

From his observations, he classified the injuries into 5 distinct groups:

- Pure flexion injuries
- Flexion-rotation injuries
- Extension injuries
- Compression injuries
- Shearing injuries

The flexion of the spine causes pure flexion injuries and results in a crushing of the anterior part of the vertebra (a wedge fracture). This fracture remains stable because the posterior ligament complex is intact. With the additional rotation of the spine and the rupture of the posterior ligament complex, a cervical flexion-rotation injury results in a dislocation of the articular processes and the rupture of the intervertebral disc. This injury is unstable.

Extension of the cervical spine may cause an extension injury, with the rupture of the anterior longitudinal ligament and intervertebral disc. The posterior ligament complex is not injured and the injury is stable as long as the cervical spine is not extended.

Compression injuries occur when force is applied longitudinally to the cervical spine and "one or the other vertebral end plate fractures and the nucleus of the disc is forced into the vertebral body which explodes"(3) (a burst fracture). The ligaments are intact and the injury is stable.

When a powerful force is applied to the posterior part of the neck, the violence may cause a shearing injury, whereby the upper vertebra is forced anteriorly relative to the lower vertebra, the articular processes fracture and all ligaments rupture. When this injury occurs in the cervical spine, it is unstable.

The classification is made based on x-ray findings and the results of a clinical examination.

Although it is not part of the classification, Holdsworth stresses the importance of obtaining as full a history of the accident as possible to enable the orthopaedic surgeon to make accurate deductions(3). It is also necessary to perform a neurological examination of the pasient.

Allen's classification

In 1982, Ben Allen et al published the classification of "Closed, Indirect Fractures and Dislocations of the Lower Cervical Spine"(4). They hypothesise that the mechanism that causes an injury can be deduced from the radiographical findings, that similar injuries are caused by similar injury mechanisms and that within each injury class "there is a spectrum of injury which ranges from trivial to severe"(4). Based on the study of 165 cases, they opt for a mechanistic classification and within each group they classify each injury into a subgroup (stage) based on radiographic pathology.

- Compressive flexion (5 stages)
- Vertical compression (3 stages)
- Distractive flexion (4 stages)
- Compressive extension (5 stages)
- Distractive extension (2 stages)
- Lateral flexion (2 stages)

Compressive flexion injuries range from Stage 1 “blunting of the anterior-superior vertebral margin to a rounded contour”(4) to a Stage 5 which includes a fracture of the anterior-inferior part of the vertebral body (“beak” fracture), an oblique fracture through the vertebral body from the anterior surface to the inferior subchondral plate and displacement of the posterior portion of the vertebral body into the neural canal. Both the posterior ligamentous complex and the posterior longitudinal ligament have failed, indicated by an increased distance between spinous processes and a dislocation of the facet joints. The injury mechanism was known in 8 of the 36 cases and “the neck was postured in flexion, and the impact occurred near the vertex of the calvarium”(4). See table 1 for a sample of the classification with summary of the subsequent findings in each stage.

Classification(4)

Compressive Flexion

Stage 1	Blunting of the anterior-superior vertebral margin to a rounded contour.
Stage 2	Obliquity of the anterior vertebral body and loss of anterior height of the vertebral body (“beak” appearance). May show increased concavity of inferior end-plate and vertical fracture of the centrum.
Stage 3	A “beak” fracture and a fracture line obliquely through the vertebral body from the anterior surface to the inferior subchondral plate.
Stage 4	Less than 3 mm displacement of the inferior-posterior vertebral margin into the neural canal at the involved motion segment.
Stage 5	Displacement of the posterior portion of the vertebral body fragment into the neural canal. Intact vertebral arch. Failure of the posterior ligamentous complex and the posterior longitudinal ligament indicated by a increased distance between spinous processes and a dislocation of the facet joints.

Table 1

In the vertical compression injuries, there is a fracture of one or both of the vertebral end-plates and there may be other findings, like a fragmented vertebral body, displacement of part of the vertebral body into the neural canal, and fracture of the vertebral arch with possible fracture of the posterior ligamentous complex. In the cases where the injury mechanism was known, the injury was caused by a compressive force on the cervical spine with the neck in a neutral position(4).

Distraction flexion injuries are characterised by a failure of the posterior ligamentous complex, evidenced by an increased spacing of the spinous processes and a facet subluxation or dislocation. As seen in compression flexion, there may be a blunting of the anterior-superior vertebral margin. With increasing stage, there is also an increasing anterior motion of the superior vertebral body. The injury mechanism was known in 6 cases and in each the impact came to the back of the head when the neck was in flexion(4).

In compression extension injuries, there is a fracture of the vertebral arch, either unilateral or bilateral. There may be a subsequent anterior motion of the vertebral body (attached to its superior vertebra) while the posterior part of the arch remains attached to the inferior vertebra. This implies a rutpure of the posterior ligamentous complex and the anterior ligaments at different segments. Of the 40 cases, the injury mechanism was known in 3 cases and in each of these “there was a blow to the forehead or face which forced the neck into extension”(4).

Distractive extension injury includes either a rupture of the anterior ligamentous complex or a transverse fracture of the vertebral body. This is seen on a radiograph as an anterior widening between two adjacent vertebrae. To be classified as a stage 2 injury, there must also be a posterior displacement of the superior vertebrae, implying an additional failure of the posterior ligamentous complex. In 2 out of 9 cases, the injury mechanism was known and “in each there was a fall onto the face from a height”(4).

In lateral flexion injuries, there is an “asymmetric compression fracture of the vertebral body plus vertebral arch fracture on the ipsilateral side”(4). There may also be lateral displacement of the vertebra or contralateral facet dislocation due to the failure of the lateral ligaments. The injury mechanism was known in 1 of 5 cases, where “the head was slowly forced toward the shoulder so that the patient's ear was against the shoulder”(4).

Harris' classification

In 1986, Harris et al published “A Practical Classification of Acute Cervical Spine Injuries”(5). This was an attempt at a “meaningful and useful” classification system that was “simple, pragmatic, understandable and had equal application for the clinician and the theorist”(5). In the article, the authors do not review pasient cases, but instead base the system on previously published works and their own opinions and knowledge. The classification has 7 main categories with subgroups.

- Flexion (5 subgroups)
- Flexion rotation
- Extension-rotation
- Vertical compression (2 subgroups)
- Hyperextension (7 subgroups)
- Lateral flexion
- Diverse or imprecisely understood mechanisms (2 subgroups)

Only spinal injury classes and subgroups referring to subaxial injury will be presented[1].

Classification(5)

Flexion

Anterior subluxation	Hyperkyphotic angulation at the level of injury and a disruption in the posterior ligament complex with anterior subluxation.
Bilateral interfacetal dislocation	Dislocation of facet joints bilaterally with rupture of all ligamentous structures. Anterior displacement of the vertebra with its inferior facets anterior to the subjacent vertebra's superior facets.
Simple wedge fracture	Fracture of the anterior part of the vertebra with decreased height and rupture of the posterior ligament complex.
Clay-shoveler fracture	Avulsion fracture of the spinous process.
Flexion teardrop fracture	A fracture of the anterior-inferior part of the vertebra with rupture of all ligaments and the intervertebral disc. Also dislocation of the facet joints.

Table 2

Flexion injury is classified into 5 subgroups (see table 2). Flexion-rotation injury includes unilateral interfacetal dislocation where a facet joint on one side is dislocated, resulting in rupture of the posterior ligament complex. The anterior ligament complex may also be ruptured(5).

The pillar fracture is an extension-rotation injury where the articular pillar has a vertical fracture due to the vertebra's collision with the superjacent vertebra(5).

Classification(5)

Hyperextension

Hyperextension Dislocation	Only observed experimentally or at autopsy. Rupture of the longitudinal ligaments, with a separation from the subjacent vertebra either by a rupture of the intervertebral disc or by a rupture between the inferior end-plate and the intervertebral disc with a possible avulsion fracture of the anterior part of the inferior end-plate.
Laminar fracture	Fracture of the lamina (between the articular mass and the spinal process).
Hyperextension Fracture-Dislocation	Fracture of both the articular masses or one articular mass and a contralateral facet dislocation. There is also a anterior displacement of the affected vertebra.

Table 3

Vertical compression injury includes the burst fracture, where the fragmentation of the vertebral body results in bone fragments pushed back into the spinal

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[1] The Jefferson bursting fracture, the avulsion fracture of the anterior arch of the atlas, the extension teardrop fracture of the axis, the fracture of the posterior arch of the atlas, Hangman's fracture, the atlanto-occipital disassociation and the odontoid fractures are not covered.

canal. There is also a posterior arch fracture and a vertical fracture in the vertebral body(5).

Hyperextension injury has 7 subgroups of which 3 are covered in table 3.

Lateral flexion is the final group and includes the uncinate process fracture that is a result of a sideways tilting of the head/neck(5).

The Subaxial Cervical Spine Injury Classification System (SLIC)

Vaccaro et al published the Subaxial Cervical Spine Injury Classification System in 2007(1), based on both expert opinion and a literature review. In addition, the authors compared the new classification system to Allen's classification and Harris' classification.

The SLIC system consist of 3 main components: injury morphology, disco-ligamentous complex (DLC) and neurological status (see table 4 for complete scale). Compression injury in this case is defined as “a visible loss of height through part of an entire vertebral body, or disruption through an end-plate”(1). A distraction injury includes both flexion and extension injury, but where there is “evidence of anatomic dissociation in the vertical axis”(1), i.e. with a partial or complete disruption of either or both of the anterior ligamentous complex and the posterior ligamentous complex. To qualify for a rotation/translation injury, there has to be “horizontal displacement of 1 part of the subaxial cervical spine with respect to the other”(1).

SLIC Scale

	Points
Morphology	
No abnormality	0
Compression	1
Burst	+1 = 2
Distraction	3
Rotation/translation	4
Disco-ligamentous complex (DLC)	
Intact	0
Indeterminate	1
Disrupted	2
Neurological status	
Intact	0
Root injury	1
Complete cord injury	2
Incomplete cord injury	3
Continuous cord compression in setting of neurological deficit	+1

Table 4

The disco-ligamentous complex consists of the anterior and posterior longitudinal ligaments, the intervertebral disc, the facet capsules, interspinous and supraspinous ligaments, and the ligamentum flavum, i.e. both the anterior ligamentous complex and the posterior ligamentous complex. An “abnormal widening of the anterior disc space” and an “abnormal facet alignment” are taken as “absolute indication of DLC disruption”(1), while an MRI finding like a “high signal intensity seen horizontally through a disc involving the nucleus and anulus on a T2 sagittal MRI”(1) is suggestive of DLC disruption. Another sign of disruption is a widening of the space between 2 spinous processes. Increased water content as seen on T2-weighted MRI and interpreted as a sign of oedema should be classified as indeterminate(1).

SLIC Interrater Reliability(1)

Measure	*Kappa*	*ICC*
SLIC		
Injury morphology	0.51	0.57 ± 0.02
DLC	0.33	0.49 ± 0.02
Neurologic status	0.62	0.87 ± 0.01
Total SLIC	0.20	0.71 ± 0.01
Management	0.44	0.58 ± 0.02
Allen	0.53	
Harris	0.41	

Table 5

Neurological status is included in the classification because it is “an important indicator of the severity of spinal column injury” and “significant neurological injury infers a significant force of impact and potential instability to the cervical spine”(1). The authors postulate that “neurological status may be the single most influential predictor of treatment”(1).

The sum of the 3 classes in the SLIC scale is then computed and confounders[2] are noted. If the score is between 1-3, the patient does not receive surgery, while for a score ≥ 5 surgery is recommended(1).

SLIC Intrarater Reliability(1)

Measure	*Kappa*	*ICC*
SLIC		
Injury morphology	0.65	0.75 ± 0.07
DLC	0.50	0.66 ± 0.09
Neurologic status	0.72	0.90 ± 0.03
Total SLIC	0.39	0.83 ± 0.05
Management	0.60	0.77 ± 0.06
Allen	0.63	
Harris	0.53	

Table 6

The classification system was then tested in a clinical setting, where 20 surgeons reviewed 11 clinical cases and classified the injuries according to the Allen classification, Harris' classification and the SLIC scale to test interrater reliability. Six weeks later, the same cases where reclassified to test intrarater reliability. The results are presented in tables 5 & 6 and show that when using the kappa coefficient, the new SLIC scoring system's individual components have a comparable reliability to the Allen and Harris classifications, but that the total SLIC score has interrater and intrarater reliability of $\kappa = 0.20$ and $\kappa = 0.39$ respectively which is worse than for the Allen and Harris systems(1).

When comparing the independent assessment of whether to perform surgery or not to the recommendations of the SLIC score, when excluding SLIC score = 4, the agreement among raters was 93,3%(1).

Cervical Spine Injury Severity Score (CSISS)

The “Cervical Spine Injury Severity Score” was published by Moore et al in 2006(6). They propose a scoring system where 0-5 points are given based on the severity of the fracture and ligamentous injury in 4 spinal columns (anterior, posterior, right pillar, left pillar), with 0 being no injury and 5 being the worst possible injury in the affected column. The 4 spinal columns where defined to include the following structures(7):

- anterior: vertebral body, vertebral disc, anterior and posterior longitudinal ligaments, uncinate processes and transverse processes
- posterior: the spinous process, the laminae, the posterior ligamentous complex and the ligamentum flavum
- lateral pillars: lateral masses, pedicle, transverse processes[3], superior and inferior articular processes and the facet capsules.

The scores are then summed to a final injury severity score.

Initially, the reliability was tested in 40 patient cases (35 consecutive cases and repeated reliability testing of 5 cases) by 10 reviewers. This showed an interobserver intraclass correlation coefficient (ICC) ranging from 0.75 to 0.98 depending on the case, with an average of 0.88.

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[2] Confounders suggested by the authors: “presence of ankylosing spondylitis, diffuse idiopathic hyperostosis, osteoporosis, previous surgery, degenerative disease”(1).

[3] The transverse processes are included in both the anterior column and the lateral pillars.

Intraobserver reliability ranged from 0.97 to 0.99(6).

In a later study by Anderson et al, the system was evaluated by 15 examiners who each studied 39 patient cases (34 unique patient cases and an additional 5 random cases from the initial 34). The classification system shows high reliability with intraobserved reliability of 0.977 measured by the ICC. Interobserver reliability was 0.883 measured by the same technique. Of the cases with a score ≥7, all pasients where treated surgically. Of the patients undergoing surgery, only 4 of 20 had a score <7(7).

A worst-case analysis was also conducted of the cases that showed highest variability. This showed that in certain cases, some injuries had been overlooked by some examiners. Also, in some cases the ligamentous damage was underestimated by some examiners, mainly attributed to limitations of computer tomography imaging(7).

Discussion

As proposed by Mirza et al(8) for the classification of thoracic and lumbar fractures, there are a number of criteria that need to be fulfilled in an ideal spinal classification system. The main purpose of a classification system is to allow a grading of severity based on radiological and clinical (neurologic) characteristics, an identification of pathogenesis and mechanism of injury, a guide for choice of treatment and to predict outcome (prognosis)(8). As stated by Moore at al, expectations include "identification and terminology, injury and treatment, characterization, neurological factors, grading, and prognosis"(6). High interrater and intrarater reliability is preferred when grading the injury so as to avoid misdiagnosis. However, it may not be possible to fulfil all these criteria. As stated by Anderson et al, it is clear that as a classification system becomes too detailed, it may become burdensome to use, while a simple classification system may not have sufficient classes to be of clinical use(7).

In this context, the classification system by Holdsworth does not fulfil all criteria. Holdsworth bases his classification on a study of over 1000 patients, but does not do this systematically and it is therefore not possible to control and review his observations. His classification system is simple, in that "once the classification is understood, it is easy to diagnose the various types of fractures and fracture-dislocations"(3), but the risk is a too broad grouping which unables the use of the classification to guide treatment and predict outcome. The neurological examination is confirmed by Holdsworth to be of importance in the choice of treatment(3), but it is not included in the classification system. He makes treatment suggestions, but there are multiple considerations that are not in his classification that need to be evaluated before the choice is made(3), and this reduces the applicability of the classification system.

Allen's classification system tries to identify the mechanism of injury and bases this on bio-mechanical studies and patient histories(4). However, the number of known patient histories in each group is small compared to the number of patients and this reduces the certainty of the assumed common mechanism. Since it is possible to see a common pathology among patients with a certain injury mechanism, Allen et al deduce that all patients with this pathology have experienced the same injury mechanism(4). This is a logical fallacy that is not considered by the authors. A further problem is that in the case of CE stage 3 and 4, these conditions are extrapolated from known pathology since these subgroups have not been observed by the authors.

The authors demonstrate a tendency for cases in a higher stage to have a higher probability of neurological damage, except for the CE group. However, with a low number of patients in each subgroup, no further statistical analysis is performed. This makes it difficult to use the findings to predict the risk of neurological damage in a clinical system based on the Allen classification system.

Instability is defined by the authors as "greater than normal range of motion within a motion segment"(4) and they acknowledge that there are degrees of instability. They show that treatment considerations depend on the stability of the injury and that the stability of the injury can to a certain degree be deduced from the group and stage. However, further considerations include neurological damage, "associated injuries, medical disorders and unique individual factors"(4) and that there is no "data-base approach to treatment"(4). It is therefore uncertain to what degree the classification system can be used to guide treatment. Outcome is not considered by the authors.

Harris' classification is based on "injuries, or groups of injuries, generally accepted to be caused by predominant vector forces or combinations of such forces"(5). It is not clear which exact criteria have been used when deciding which injuries to include and which to exclude. The classification mainly uses radiological findings, but neurological findings are additionally used if this is important for distinguishing different groups. Stability of an injury is deduced from the radiological observations(5), but is not used further to guide treatment. Because the classification system has not been evaluated with pasient data, it is difficult to know how it will perform, especially concerning reliability. One must therefore look to other studies to evalute the performance of this classification system(1). Of the initial criteria, the classification does not guide treatment and does not predict outcome.

The SLIC system as presented by Vaccaro et al, succeeds in fulfilling many of the criteria for an ideal classification system. It allows for a grading of severity both from a radiological and neurological perspective. Based on the SLIC score, guiding of treatment is possible. In cases of SLIC score <3 non-operative treatment may be rendered, while for a score ≥ 5 surgery is recommended(1). Further development of treatment suggestions based on the SLIC score has been made by Dvorak et al, where they in a systematic review demonstrate an evidence-based algorithm for treatment choice(9). This algorithm was not tested in a clinical setting. When the reliability of the SLIC system is compared to the Allen and Harris systems by the kappa coefficient, the SLIC system fares worse than the older systems (see table 5 and 6). However, as found by Patel et al when adopting the Thoracolumbar Injury Classification and Severity Score (TLISS) in a clinical setting, there was a significant increase in interobserver reliability as measured by the kappa coefficient after 7 months of clinical use(10). This indicates that the use of a new classification system may increase its interrater reliability.

Patel et al have compared different acute subaxial cervical classification systems(11). They conclude that there are weaknesses with the Holdsworth, Allen and Harris systems because "these systems, in essence, compartmentalize injuries into a variety of anatomic fracture patterns based on an arbitrary inference of mechanism that, in reality, may have had little to do with the actual injury"(11). Conversely, the SLIC system is "based on information at hand rather than inference" and "the SLIC system and severity scale is the first classification system to abandon an inferred mechanism of injury"(11).

The CSISS as presented by Moore et al allows the classification of injury by radiological findings. It does not include neurologic function in the classification itself, as this can be scored separately using another classification system(6). Although Anderson et al claim that "CSISS accurately predicted the need for surgery"(7), this is only true for patients with a score ≥7 as all these patients underwent surgery. Of the patients with a score <7, only 4 of 20 patients had surgery and for this group the scoring system could not stratify the patients. The scoring system has not been evaluated with respect to prognosis.

When comparing the CSISS with the SLIC system, the CSISS has higher interrater (0.88 and 0.71 respectively) and intrarater (0.98 and 0.83 respectively) reliability as found with the ICC.

As claimed by Helgeson et al, the SLIC system "as of right now, seems to be the best classification system available for subaxial cervical spine trauma"(12). When compared to the criteria presented by Mirza et al, this certainly seems to be the case since this classification system fulfils most of the criteria, while the other classification systems do not. However, when comparing the interrater and intrarater reliability of the system to Allen, Harris and the CSISS, the SLIC system fares worse(1)(6)(7). Therefore there is a need for further study and evaluation of the SLIC system.

Conclusion

This thesis highlights 5 classification systems of subaxial cervical spine injury. By comparing these, it is evident that older classification systems (Holdsworth, Allen et al and Harris et al) have focused on the mechanisms of injury while newer classification systems (Vaccaro et al, Moore et al) have discarded this in favour of radiological findings and, in the case of Vaccaro et al, neurologic status. Comparisons of the classification systems show that there are clear advantages to the system presented by Vaccaro et al (SLIC scale) compared to previous systems because it may be used to guide treatment, however it has lower reliability and validity compared to the Allen and Harris systems. The CSISS has a high interrater and intrarater reliability than the SLIC scale but is not suitable for guiding treatment for injuries with scores <7 and does not include neurological status. There is a need for further study and evaluation of the SLIC system to ascertain its true reliability in a clinical setting.

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