AOSpine subaxial cervical spine injury classification system

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- Outcome and complications of operatively treated subaxial cervical spine injuries: A population-based retrospective cohort study
- Teachability of lower cervical spine injury classifications
- Guideline-conform treatment of injuries to the subaxial cervical spine
- Cervical spine trauma: impact of different imaging classification systems in the clinical decision-making
- Guideline-conform diagnostics for injuries of the subaxial cervical spine
- Epidemiology and Imaging Classification of Pediatric Cervical Spine Injuries: 12-Year Experience at a Level 1 Trauma Center
- AOSpine Subaxial Cervical Spine Injury Classification System: The Relationship Between Injury Morphology, Admission Injury Severity, and Long-Term Neurologic Outcome
- AOSpine-Spine Trauma Classification System: The Value of Modifiers: A Narrative Review With Commentary on Evolving Descriptive Principles

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The AO Spine Subaxial Injury Classification System demonstrated excellent interobserver reliability and intraobserver reproducibility for fracture morphology, substantial reliability and reproducibility for facet injuries, and excellent reproducibility with substantial reliability for injury subtypes [1)].

The AO Spine Subaxial Cervical Spine Injury Classification System has shown to be reliable and suitable for proper patient management. The study shows this classification is substantially generalizable by geographic region and surgeon experience, and provides a consistent method of communication among physicians while covering the majority of subaxial cervical spine traumatic injuries.Level of Evidence: 4 [2)].

This project describes a morphology-based subaxial cervical spine injury classification system. Using the same approach as the AOSpine thoracolumbar spine injury classification system, the goal was to develop a comprehensive yet simple classification system with high intra- and interobserver reliability to be used for clinical and research purposes.

It was developed using a consensus process among clinical experts. All investigators were required to successfully grade 10 cases to demonstrate comprehension of the system before grading 30 additional cases on two occasions, 1 month apart. Kappa coefficients (κ) were calculated for intraobserver and interobserver reliability.

The classification system is based on three injury morphology types similar to the TL system: compression injuries (A), tension band injuries (B), and translational injuries (C), with additional

descriptions for facet injuries, as well as patient-specific modifiers and neurologic status. Intraobserver and interobserver reliability were substantial for all injury subtypes (κ = 0.75 and 0.64, respectively).

The AOSpine subaxial cervical spine injury classification system demonstrated substantial reliability in this initial assessment, and could be a valuable tool for communication, patient care and for research purposes [3].

The AOSpine subaxial cervical spine injury classification system (using the four main injury types or at the sub-types level) allows a significantly better agreement than the Allen and Ferguson classification of subaxial cervical spine injury. The A&F scheme does not allow reliable communication between medical professionals [4].

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see also Subaxial Injury Classification (SLIC).

Sort

The classification system describes injuries based on four criteria:

Morphology of the injury

Facet injury

see Facet injury.

There was significant variability in diagnostic accuracy for F1 facet fracture through F3-type fractures, whereas almost universal agreement was achieved for F4-type injuries [5].

Neurologic status

Case-specific modifiers

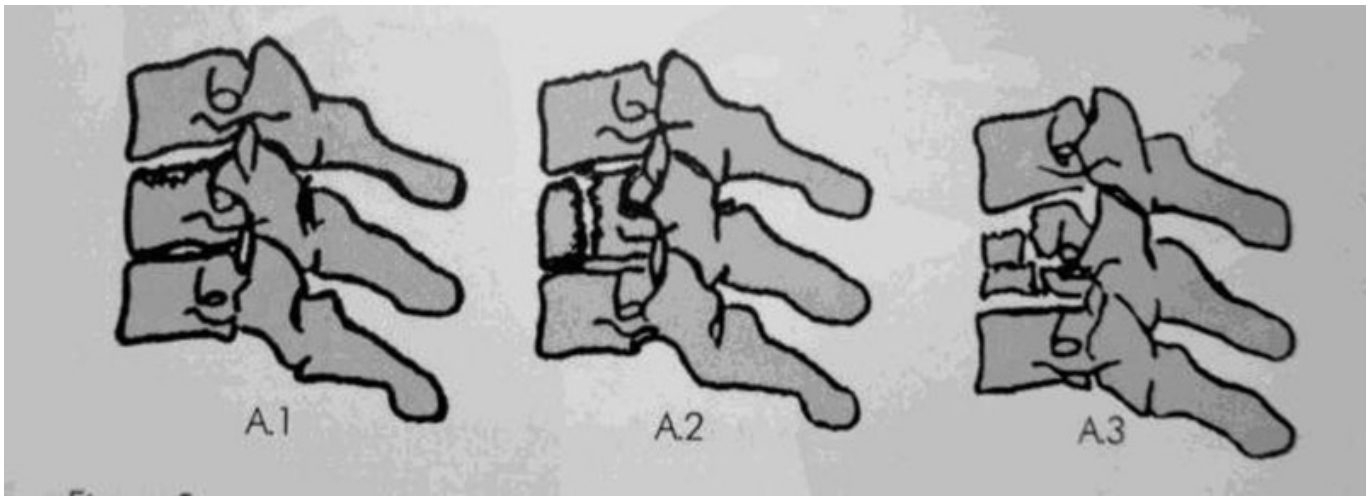
Injuries are described by their level, followed by the morphologic type of the primary injury. The secondary injuries and modifiers are placed in parentheses (facet injury, neurologic status, and case specific modifiers).

Still widely used by various centers, the classification of lower cervical fractures recommended by the AO group consists of three types (A, B and C), which are extended into groups and subgroups. The types describe the trauma mechanism (A: compression; B: distraction; C: rotation), while the groups and subgroups define the morphological parameters. This classification represents a ranking that follows a prognostic hierarchy, i.e., as one progresses through the classification, the severity becomes

theoretically higher and the prognosis worsens. The AO classification of fractures of the lower cervical spine (C3-C7) [6].

Type A

Type A injuries are fractures that result in compression of the vertebra with intact tension band.



AO classification. A compression: A.1 = impaction; A.2 = split; A.3 = burst.

Type A0 is used to describe insignificant fractures not affecting the spinal stability in a significant way, such as an isolated fracture of the spinous process, the transverse process or the lamina.

Type A1 injuries are compression fractures involving a single endplate without involvement of the posterior wall of the vertebral body

Caution: If this fracture is seen at the cervicothoracic junction, it is likely that this is part of a type B or type C injury.

Type A2 is a coronal split or pincer fracture involving both endplates without involvement of the posterior wall of the vertebral body.

Caution: If this fracture is seen at the cervicothoracic junction, it is likely that this is part of a type B or type C injury.

Type A3 is a burst fracture involving a single endplate (superior or inferior) with involvement of the posterior vertebral wall.

Caution: If this fracture is seen at the cervicothoracic junction, it is likely that this is part of a type B or type C injury.

Type A4 is a burst fracture or sagittal split injury involving both endplates.

These injuries are similar to A3 injuries but involve both endplates. Fractures that split the vertebral body in the sagittal plane involving the posterior vertebral wall are also included in this group.

Caution: If this fracture is seen at the cervicothoracic junction, it is likely that this is part of a type B or type C injury.

Type B

Type B injuries include failure of the posterior or anterior tension band through distraction with physical separation of the subaxial spinal elements while maintaining continuity of the alignment of the spinal axis without translation or dislocation.

Type B1 is a posterior tension band injury where the fracture line only goes through the bony structure.

In the cervical spine this is a very uncommon injury.

Type B2 is a complete disruption of the posterior capsuloligamentous or bony capsuloligamentous structures together with a vertebral body, disk, and/or facet injury.

Combine with Type A fracture type and facet type injury classification when appropriate.

This always involves a motion segment and should be called an injury of eg. C5/C6.

Type B3 is an anterior tension band injury.

There is physical disruption or separation of the anterior structures (bone/disk) with tethering of the posterior elements.

These injuries may pass through either the intervertebral disk or through the vertebral body itself (as in the ankylosed spine). An intact posterior hinge will prevent gross displacement

Type C

AO Spine Subaxial Injury Type C

Type F

AO Spine Subaxial Injury Type F

Neurology

Neurological status is graded according to a six-part system similar to the system described with the TL classification:

N0: neurologically intact

N1: transient neurologic deficit that has completely resolved by the time of clinical examination (usually within 24 h from the time of injury)

N2: radiculopathy

N3: incomplete spinal cord injury

N4: complete spinal cord injury

NX: neurology undetermined (used to designate patients who cannot be examined due to head injury or another condition which limits their ability to complete a neurological examination such as intoxication, multiple trauma, or intubation/sedation). There is one difference with the system used in the TL classification:

‘‘+’’ is given in the case of ongoing cord compression in setting of incomplete neurologic deficit or nerve injury.

Case specific modifiers

The case specific modifiers describe unique conditions relevant to clinical decision making.

M1 PLC injury suspected

This modifier designates injuries, which may appear stable from a bony standpoint, but there is some evidence of injury to the posterior ligamentous complex (PLC) without complete disruption. This is often identified on MRI imaging and associated with very localized posterior tenderness on clinical examination.

M2 Critical disk herniation

M2—Critical disk herniation defined by tissue signal intensity that is consistent with nucleus pulposus protruding posteriorly to a vertical line drawn along the posterior border of the inferior vertebral body at the injured level.

M3 Stiff spine

M3—Stiffening/metabolic bone disease [i.e., Diffuse Idiopathic Skeletal Hyperostosis (DISH), Ankylosing Spondylitis (AS), Ossification of the Posterior Longitudinal Ligament (OPLL) or Ossification of the Ligamentum Flavum (OLF)]. This modifier describes conditions that may argue either for or against surgery for those patients.

These injuries are highly unstable.

M4—Signs of vertebral artery injury.

Disruption or dissection of the vertebra artery may influence the decision making for treatment.

Nomenclature

To build up the complete classification, the following step by step approach is used.

Start with (sub)types A, B or C

B and C always segment (i.e. C4-C5) In B or C combine with the description of vertebral body fracture:

C4-C5: B2 (C5: A4) Add facet description. First right, then left side.

C4-C5: B2 (C5: A4, F2, F4) Add neurology

C4-C5: B2 (C5: A4; F2, F4; N3) Add modifier if necessary

C4-C5: B2 (C5: A4; F2, F4; N3; M2).

Classification Options Preliminary remarks Morphology of the injury A0 A1 A2 A3 A4 B1 B2 B3 C Facet injury Neurology Case specific modifiers Nomenclature Preliminary remarks The classification system described here exists in order to provide surgeons from different institutions with a common language to discuss various injuries. It provides consistency in injury diagnosis and treatment.

The AOSpine subaxial cervical spine fracture classification system aims to achieve international acceptance.

The classification system describes injuries based on four criteria:

morphology of the injury facet injury neurologic status case-specific modifiers Each criterion is described below. Injuries are described by their level, followed by the morphologic type of the primary injury. The secondary injuries and modifiers are placed in parentheses (facet injury, neurologic status, and case specific modifiers).

Morphology of the injury

enlarge Three basic categories (Types) were used in a similar manner to the AO Thoracolumbar spine fracture classification system to describe primary injury morphology.

Type A injuries are fractures that result in compression of the vertebra with intact tension band.

Type B injuries include failure of the posterior or anterior tension band through distraction with physical separation of the subaxial spinal elements while maintaining continuity of the alignment of the spinal axis without translation or dislocation.

Type C includes those injuries with displacement or translation of one vertebral body relative to another in any direction; anterior, posterior, lateral translation, or vertical distraction.

Injuries are first classified by their level and either C, B, or A in this order.

A0

enlarge Type A0 is used to describe insignificant fractures not affecting the spinal stability in a significant way, such as an isolated fracture of the spinous process, the transverse process or the lamina.

enlarge This CT shows a sagittal reconstruction of an isolated spinous process fracture.

enlarge This CT shows a transverse image of the same injury.

A1

enlarge Type A1 injuries are compression fractures involving a single endplate without involvement of the posterior wall of the vertebral body

Caution: If this fracture is seen at the cervicothoracic junction, it is likely that this is part of a type B or type C injury.

enlarge This CT show a sagittal reconstruction of a C7 superior endplate A1 fracture.

A2

enlarge A-type injuries are in general a failure of anterior structures under compression with intact tension band.

Type A2 is a coronal split or pincer fracture involving both endplates without involvement of the posterior wall of the vertebral body.

Caution: If this fracture is seen at the cervicothoracic junction, it is likely that this is part of a type B or type C injury.

enlarge This CT show a sagittal reconstruction of a C3 type A2 fracture.

A3

enlarge A-type injuries are in general a failure of anterior structures under compression with intact tension band.

Type A3 is a burst fracture involving a single endplate (superior or inferior) with involvement of the posterior vertebral wall.

Caution: If this fracture is seen at the cervicothoracic junction, it is likely that this is part of a type B or type C injury.

enlarge This CT show a sagittal reconstruction of a C7 burst A3 fracture.

A4

enlarge A-type injuries are in general a failure of anterior structures under compression with intact tension band.

Type A4 is a burst fracture or sagittal split injury involving both endplates.

These injuries are similar to A3 injuries but involve both endplates. Fractures that split the vertebral body in the sagittal plane involving the posterior vertebral wall are also included in this group.

Caution: If this fracture is seen at the cervicothoracic junction, it is likely that this is part of a type B or type C injury.

enlarge This CT show a sagittal reconstruction of a C7 burst A4 fracture.

B1

enlarge B-type injuries are in general a failure of the posterior or anterior tension band.

Type B1 is a posterior tension band injury where the fracture line only goes through the bony structure.

In the cervical spine this is a very uncommon injury.

B2

enlarge B-type injuries are in general a failure of the posterior or anterior tension band.

Type B2 is a complete disruption of the posterior capsuloligamentous or bony capsuloligamentous structures together with a vertebral body, disk, and/or facet injury.

Combine with Type A fracture type and facet type injury classification when appropriate.

This always involves a motion segment and should be called an injury of eg. C5/C6.

enlarge This CT show a sagittal reconstruction of a C7/T1 ligamentous B2 injury without a fracture.

B3

enlarge B-type injuries are in general a failure of the posterior or anterior tension band.

Type B3 is an anterior tension band injury.

There is physical disruption or separation of the anterior structures (bone/disk) with tethering of the posterior elements.

These injuries may pass through either the intervertebral disk or through the vertebral body itself (as in the ankylosed spine). An intact posterior hinge will prevent gross displacement

enlarge This CT show a sagittal reconstruction of an C5/C5 ligamentous B3 injury.

C

enlarge C-type injuries are in general failure of anterior and posterior elements leading to displacement

This category includes injuries with displacement or translation of one vertebral body relative to another in any direction.

Any associated injury (either a Type A or facet injury) should be specified separately as a subtype, after designation as a Type C injury.

enlarge This CT show a sagittal reconstruction of a C7/T1 type C injury.

Facet injury A series of descriptors describes the spectrum of injuries to the facet joint complex.

If there are multiple injuries to the same facet (for example, a small fracture and dislocation), only the highest level of injury is classified (dislocation).

If both facets on the same vertebrae are injured, the right-sided facet injury is listed before the left sided injury if the injuries are of different subcategories.

The ‘‘Bilateral’’ (BL) modifier is used if both facets have the same type of injury.

If only facet injuries are identified (no A, B, or C injury), they are listed first after the level of injury.

enlarge F1 Non displaced facet fracture

F1 is a non-displaced facet fracture (either superior or inferior facets). Fracture fragments are smaller than 1 cm and comprise less than 40% of the lateral mass.

enlarge F2 facet fracture with potential for instability (either superior or inferior facets)

F2 is a facet fracture with potential for instability (either superior or inferior facets).

Fracture fragments are either larger than 1 cm, comprise more than 40% of the lateral mass, or there are signs of displacement.

enlarge This CT show a sagittal reconstruction of a facet fracture C5/C6 (F2).

enlarge F3 Floating lateral mass

F3 is a disruption of the pedicle and lamina resulting in disconnection of superior and inferior articular processes at a given level or set of levels.

This might lead to instability of the facet joint of two motion segments.

enlarge This CT shows a transverse image of a lateral mass fracture at the level of C5 (F3).

enlarge F4 Pathologic subluxation or perched/dislocated facet

This injury type includes any subluxation or dislocation of the facet joint, with or without fracture.

enlarge This CT shows a sagittal reconstruction of a dislocated and locked facet at C7/T1 (F4).

enlarge BL—Bilateral

The bilateral modifier is used when the same type of facet injury is observed bilaterally on the same vertebra.

Case series

2017

Aarabi et al. analyzed the relevant clinical, imaging, management, and American Spinal Injury Association (ASIA) impairment scale (AIS) grade conversion of 92 AIS grades A-C patients with cervical spine injury. We correlated morphology class with age, injury severity score (ISS), follow-up ASIA motor score (AMS), intramedullary lesion length (IMLL), and AIS grade conversion at 6 months after injury.

The mean age of patients was 39.3 years, 83 were men, and 69 were injured during an automobile accident or after a fall. The AOSpine class was A4 in 8, B2 in 5, B2A4 in 16, B3 in 19, and C in 44 patients. The mean ISS was 29.7 and AMS was 17.1. AIS grade was A in 48, B in 25, and C in 19 patients. Mean IMLL on postoperative magnetic resonance imaging was 72 mm: A4 = 68.1; B2A4 = 86.5; B2 = 59.3; B3 = 46.8; and C = 79.9. At a mean follow-up of 6 months, the mean AMS was 39.6. Compared to patients with class B3 injuries, those with class C injuries were significantly younger ($P < 0.0001$), had longer IMLL ($P < 0.002$), and were less likely to have AIS grade conversion to a better grade ($P < 0.02$).

The AOSpine subaxial cervical spine injury classification system successfully predicted injury severity (longer IMLL) and chances of neurologic recovery (AIS grade conversion) across different class subtypes [7)].

2016

Silva et al., evaluated the new classification

Patients with subaxial cervical spine trauma (SCST) treated at the authors' institution according to the Subaxial Cervical Spine Injury Classification system were included. Five different blinded researchers classified patients' injuries according to the new AOSpine system using CT imaging at 2 different times (4-week interval between each assessment). Reliability was assessed using the kappa index (κ), while validity was inferred by comparing the classification obtained with the treatment performed.

Fifty-one patients were included: 31 underwent surgical treatment, and 20 were managed nonsurgically. Intraobserver agreement for subgroups ranged from 0.61 to 0.93, and interobserver agreement was 0.51 (first assessment) and 0.6 (second assessment). Intraobserver agreement for groups ranged from 0.66 to 0.95, and interobserver agreement was 0.52 (first assessment) and 0.63 (second assessment). The kappa index in all evaluations was 0.67 for Type A, 0.08 for Type B, and 0.68 for Type C injuries, and for the facet modifier it was 0.33 (F1), 0.4 (F2), 0.56 (F3), and 0.75 (F4). Complete agreement for all components was attained in 25 cases (49%) (19 Type A and 6 Type C), and for subgroups it was attained in 22 cases (43.1%) (16 Type A0 and 6 Type C). Type A0 injuries were treated conservatively or surgically according to their neurological status and ligamentous status. Type C injuries were treated surgically in almost all cases, except one.

While the general reliability of the newer AOSpine system for SCST was acceptable for group classification, significant limitations were identified for subgroups. Type B injuries were rarely diagnosed, and only mild (Type A0) and extreme severe (Type C) injuries had a high rate of interobserver agreement. Facet modifiers and intermediate injury patterns require better descriptions to improve their low agreement in cases of SCST [8].

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