Can Injury Type/ Subtype of the New Aospine Subaxial Cervical Trauma Classification Dictate Patient’s Treatment?

Otávio Turolo da Silva¹, MD, PhD; Sérgio Augusto Rodrigues², PhD; Enrico Ghizoni¹, MD, PhD; Helder Tedeschi¹, MD, PhD, Andrei Fernandes Joaquim¹, MD, PhD

1 Department of Neurology, Neurosurgical division, Unicamp, Campinas, SP, Brazil; 2 Unesp, Botucatu-SP, Brazil.

Conflict-of-interest statement: The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

Open-Access: This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/

Correspondence to: Andrei Fernandes Joaquim, Universidade Estadual de Campinas. Rua: Tessália Vieira de Camargo, 126, departamento Neurologia. Cidade Universitária. 13083-887 - Campinas, SP - Brasil. Email: andjoaquim@yahoo.com Telephone: +55 19 3521-7478

Received: November 1, 2020 Revised: November 20, 2020 Accepted: November 24 2020 Published online: December 28, 2020

ABSTRACT

AIM: The AOSpine Subaxial Cervical Classification (AOSCC) was proposed in 2015 to review and improve morphology aspects of cervical fractures classification. The main objective of this paper is to evaluate if the new AOSCC can predict non-surgical versus surgical management of traumatic cervical injuries.

MATERIALS AND METHODS: The AOSCC was retrospectively applied in a retrospective case series of 51 patients with subaxial cervical spine trauma (C3-7) treated according to the SLICS system by a single surgeon. The type, subtype and facet modifier were correlated with non-surgical versus surgical treatment using the t-student and Chi-Square tests.

RESULTS: Most of these patients were men (88.2%), suffered car accidents (33.3%) with a median SLIC score of 4.52 points. There was no neurological deterioration in this series. In the non-surgical group, nineteen patients (95%) were classified as type A fractures, whereas only one patient (5%) had a type C injury not surgically treated due to severe concomitant clinical complications and traumatic brain injury. In the surgically treated group, fifteen patients (48.3%) were classified as type C. The A0 group was associated to non-surgery group (p = 0.0005) and the B-C groups was significantly associated to surgery group (p = 0.0006). The F1-2-3 was associated to non-surgery group (p = 0.0102) and F4 modifier to surgery group (p = 0.0006).

CONCLUSION: Some injury patterns may predict surgical treatment, such as type C characterized by cervical dislocations. Type A injuries, despite a potential for bone healing, may requiring additional radiological investigation in the setting of neurological deficits, to define the best treatment modality.

Key words: Subaxial Cervical Spine; Trauma; Classification; Surgery

© 2020 The Author(s). Published by ACT Publishing Group Ltd. All rights reserved.

da Silva OT, Rodrigues SA, Ghizoni E, Tedeschi H, Joaquim AF. Can Injury Type/ Subtype of the New Aospine Subaxial Cervical Trauma Classification Dictate Patient’s Treatment? International Journal of Orthopaedics 2020; 7(6): 1397-1401 Available from: URL: http://www.ghnet.org/index.php/ijo/article/view/3058

INTRODUCTION

The new AOSpine Subaxial Cervical Spine Trauma Classification (AOSCC) proposed by Vaccaro et al in 2015[1], was created to improve the reliability and clinical use of the previous classification systems, such as the proposed by Magerl et al[2]. The International AO Spine Trauma Knowledge Forum had validated this new classification in some reliability studies[3-4], suggesting potential relevance to clinical practice and in the treatment decision.

Schnake et al. in 2017, reviewed the classification applying 40 cases to 9 spine experts to classify the fractures with the new AOSCC. The results were analyzed by the Kappa index to determine the reliability of the answers between observers. The inter-observer index was K=0.64 and intra-observer was K=0.75 that represents a substan-
tial agreement. Similar results were found by Vaccaro et al. in 2015 in the AO Spine validation study. Silva et al in 2016 and Urrutia et al in 2017, found similar results to these studies, however both studies the extreme divisions A0 and C were found the better agreement, however the intermediate subdivisions as A3/A4/B1/B2/B3 had a poor index between observers.

This classification is divided in four main aspects: Vertebral morphology, facet morphology, neurologic status and additional modifiers (Table 1). Vertebral morphology is divided in three groups considering mechanical impact factors: A - compression fractures, B - distraction injuries, C - rotational/translational injuries. Type A is then subdivided in five subtypes: A0 - no vertebral body, minor fracture, laminae fracture, transverse or spinal process fracture, A1 - single end plate fracture, A2 - both end plates fracture (split vertebrae) (without burst), A3 - single end plate involvement burst fracture (posterior vertebral body wall broken), A4 - both end plates burst fracture or complete burst fracture. Type B injuries are divided in: B1 - posterior bone lesion (Chance’s fractures), B2 - posterior capsular ligamentous injuries, B3 - anterior tension band lesion (generally associated with osteophytes). Finally, type C group injury had no subtypes. Facet modifiers are presented in table 1, with four subtypes. Neurological status (N) is also evaluated, considering patients as intact, with incomplete or complete deficits, radiculopathy or transient neurological deficits. Finally, special modifiers (M) were proposed to influence the final treatment guidance: M1 - posterior capsuloligamentous lesion without disruption, M2 - Critical disk herniation, M3 - Stiffening metabolic disease (DISH/AS), M4 - vertebral artery abnormally.

Considering the lack of studies of this new system, we designed this retrospective study to evaluate if the AOSCC type and subtype were enough to guide surgical versus non-operative management of cervical spine traumatic injuries.

MATERIALS AND METHODS

Patients with subaxial cervical trauma (C3 to C7) treated in our institution were included. All data was collected retrospectively after Institutional Review Board Approval (CAAE 43716615.2.0000.5404). Part of this data was part of a study assessing the reliability of the AOSCC system[10].

All patients’ treatment was conducted by a single surgeon (AFJ) who had expertise in Spine Trauma Management. To guide the surgical treatment, the Subaxial Cervical Injury Classification Score (SLICS)[1] was used. However, patients with less than 4 points were treated non-surgically and patients with 4 or more points were treated surgically (which includes those with four points). Also was applied the ASIA Impairment Scale (AIS), that is described in table 2.

Patients of our database were then retrospectively classified according to the AOCC by the treating surgeon using imaging obtained in DICOM format by Aurora PACS 2, Pixeon®. The AOSCC is presented in table 1. Patients younger than 14 years or with incomplete radiologic and clinical data were excluded.

The evaluation of the differences between the groups Surgery and non-Surgery was made by using of t-student test for quantitative variables (age). For the qualitative variables, presented by absolute and percentual (%) frequencies, was used the Chi-Square test. A significance level of 5% was used and all analysis was realized in a R-Gui (R CORE TEAM. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. 2018. Available in http://www.R-project.org/).

To the statistical analysis, the morphologies were separated in 5 groups: A0, A1-2-3-4 and B-C, F1-2-3 and F4 based on Magerl concepts of severity and stability.

RESULTS

Fifty-one patients were included. Forty-five patients (88.2%) were male and six (11.2%) were female. The median age of these patients was 39.29 years-old (ranging from 17 to 82 years-old). The main mechanism of trauma was car accident with 33.3% of the cases. The mechanism of trauma was car accident (23.5% of the cases). The median SIC score 4.52 points (ranging from 0 to 11, mean of 4.52).

Non-surgically managed group

There were 20 patients treated non-surgically. All of them had a cervical collar prescribe for 8 to 12 months. Seventeen patients (85%) were male and had a median age of 39.4 years old. The median fol-

Table 1 The new AO Spine Subaxial Cervical Classification (AOSCC)[1].

| Vertebral Morphology | Facet Morphology |
|----------------------|------------------|
| A Compression injury | F1 - no displacement | F1 - no displacement |
| A0 no bone lesion / minor fracture | F2 - >1cm, >40% or displacement |
| A1 - single plate compression | F3 - floating lateral mass |
| A2 - “split vertebrae”, both plate fracture | F4 - subluxation or punched |
| A3 - single plate burst | BL - bilateral injury |
| A4 - both plates burst |
| B Tension band injuries |
| B1 - posterior tension band injury (bone) |
| B2 - posterior tension band injury (capsuloligament) |
| B3 - anterior band injury |
| C Rotation / Translational injuries |

Table 2 ASIA Impairment Scale.

| Grade | Definition |
|-------|------------|
| A | Complete. No sensory or motor function is preserved in the sacral segments S4-S5 |
| B | Incomplete. Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5 |
| C | Incomplete. Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3 (Grades 0-2). |
| D | Incomplete. Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade greater than or equal to 3. |
| E | Normal. Sensory and motor functions are normal. |

Table 3 Non-Surgery Group.

| N | Sex | Age | Mechanism | SLICS | AIS | Complications | M | F |
|---|-----|-----|-----------|-------|-----|---------------|---|---|
| 1 | M | 24 | Car accident | 1 | E | | A0 | F2 |
| 2 | M | 51 | Motorcycle | 0 | E | | A0 |
| 3 | F | 38 | Aggression | 1 | E | | A0 |
| 4 | M | 75 | Car accident | 1 | E | | A0 | F2 |
| 5 | M | 22 | Fall | 0 | E | | A0 | F2 |
| 6 | M | 30 | Car accident | 0 | E | | Head trauma | A0 | F1 |
| 7 | F | 24 | Motorcycle | 0 | E | | Head trauma | A0 | F3 |
| 8 | M | 29 | Car accident | 0 | E | | Lisetheresia | A0 | F2 |
| 9 | M | 54 | Car Accident | 3 | C | | A0 | F1 |
| 10 | M | 19 | Motorcycle | 0 | E | | A0 |
| 11 | M | 47 | Fall | 0 | E | | A0 |
| 12 | F | 42 | Running over | 0 | E | | A3 |
| 13 | M | 30 | Car accident | 0 | E | | A0 | F2 |
| 14 | M | 43 | Motorcycle | 2 | A | | A0 |
| 15 | M | 64 | Car accident | 7 | C | | C | F4 |
| 16 | M | 66 | Fall | 0 | E | | A0 | F1 |
| 17 | M | 17 | Aggression | 0 | E | | A0 |
| 18 | M | 49 | Car accident | 0 | E | | A1 |
| 19 | M | 37 | Aggression | 4 | C | | A0 |
| 20 | M | 31 | Motorcycle | 0 | E | | A0 |
Surgically managed group

There were thirty-one patients who had undergone surgical treatment, twenty-nine patients were men (90.3%) and a median age of 39 years old.

The SLICS median was 6.67 points (ranging from 4 to 11). Before the surgery there were nine patients with neurological deficits that improved during the follow-up. Six patients without deficits had surgery and all had a type C fracture.

Eleven patients were classified as subtype A0 (35.4%), four patients with A4 (12.9%), one patient with B2 (3.2%) and fifteen patients as type C (48.3%). Seven patients (22.5%) with minor lesion on CT Scan (A0), were operated after MRI due to critical disc herniation (M2).

Eleven patients had no facet fracture (35%), two patients had F1 (6.4%), two patients had F2 (6.4%) and sixteen patients (51.6%) had F4 morphology. All patients with type C injuries had a F4 facet modifier (Table 4). We had no type F3 injury in our study.

Table 4 Surgery group.

| N | Sex | Age | Mechanism | SLICS | AIS | Complications | M | F |
|---|-----|-----|-----------|-------|-----|----------------|---|---|
| 1 | 1 | 23 | Car accident | 8 | A | Respiratory | C | F4 |
| 2 | 2 | 48 | Car accident | 7 | E | Infection | C | F4 |
| 3 | 3 | 27 | Car accident | 7 | A | C | C | F4 |
| 4 | 4 | 23 | Sports practice | 6 | E | C | F4 |
| 5 | 5 | 65 | Car accident | 9 | C | C | F4 |
| 6 | 6 | 56 | Collision | 7 | E | C | F4 |
| 7 | 7 | 20 | Diving | 7 | O | A4 |
| 8 | 8 | 43 | Car accident | 4 | C | A0 |
| 9 | 9 | 27 | Car accident | 9 | O | A0 | F2 |
| 10 | 10 | 32 | Diving | 6 | C | Chronic pain | C | F4 |
| 11 | 11 | 65 | Collision | 6 | C | A0 |
| 12 | 12 | 40 | Car accident | 5 | C | A0 |
| 13 | 13 | 23 | Fall | 6 | E | C | F4 |
| 14 | 14 | 51 | Fall | 5 | C | A0 |
| 15 | 15 | 46 | Motorcycle | 5 | E | C | F4 |
| 16 | 16 | 40 | Motorcycle | 4 | A | Sepsis | A0 |
| 17 | 17 | 82 | Fall | 9 | B | C | F4 |
| 18 | 18 | 42 | Car accident | 6 | B | A0 |
| 19 | 19 | 39 | Car accident | 10 | A | C | F4 |
| 20 | 20 | 24 | Motorcycle | 6 | A | A4 |
| 21 | 21 | 33 | Car accident | 4 | C | A0 | F1 |
| 22 | 22 | 18 | Car accident | 4 | E | B2 | F4 |
| 23 | 23 | 45 | Fall | 4 | C | A0 |
| 24 | 24 | 30 | Car accident | 6 | A | Respiratory | A4 |
| 25 | 25 | 33 | Car accident | 7 | A | Sepsis | C | F4 |
| 26 | 26 | 39 | Motorcycle | 8 | A | A0 | F1 |
| 27 | 27 | 39 | Diving | 6 | C | A4 | F2 |
| 28 | 28 | 58 | Aggression | 8 | E | A0 |
| 29 | 29 | 34 | Diving | 10 | B | C | F4 |
| 30 | 30 | 17 | 9 | B | Respiratory | C | F4 |
| 31 | 31 | 44 | Fall | 11 | D | C | F4 |

DISCUSSION

The new AOSCC is based on the new AO system proposed for Thoracolumbar trauma derived from the previous Magerl\textsuperscript{F} classification system. Magerl et al. proposed that spinal fractures should be divided in 3 different groups according to their mechanisms of trauma in A, B and C, with increasing progressive degrees of instability. The new system had subclassifications to improve morphology description as well as facet modifiers, neurological status (similar to the SLICS system) and special modifiers.
MRI realization

F1-3 have not differences in outcomes if the surgery was delayed to receive early surgery has better neurological outcomes. Lesions with A/subtype and were neurologically intact, with statistical significance (p = 0.0102) and potentially stable lesions.

Du et al[9] reported in 2019, a series of 402 patients were underwent surgery, there is an evidence that B and C/F4 lesions that received early surgery has better neurological outcomes. Lesions with A/F1-3 have not differences in outcomes if the surgery was delayed to MRI realization[9].

In our study, all cases with subtype A4 (burst fractures), a total of four cases, were surgically treated due to neurologic impairment. However, seven patients (22.5%) had no evident bone fractures (AO) and required an MRI to detected persistent compression due to degenerative changes exacerbated in the trauma context and were surgically treated. By this reason, in the setting of neurological deficits and mild bone fractures, the CT scan based AOSCC is not enough to guide surgical management.

Our study is limited by its retrospective nature and for being a single-center, single surgeon study. However, it provides some guidance in the use of the new AOSCC in the treatment of subaxial cervical spine trauma, which may be useful for new prospective studies.

**CONCLUSION**

We reported that type C injuries were surgically managed in most of the cases and the classification of the facet modifier as F4 is redundant in this context. Additionally, mild bone fractures (such as type A0) in the setting of neurological deficits requiring an MRI, which provides limited value to the fracture severity degree of the new AOSCC. Further studies are necessary to evaluate the treatment performed in less prevalent subtype (such as type B injuries).

**ACKNOWLEDGMENTS**

Authors declare no interest conflict related to this paper content. This study is sponsored by CAPES, as part of author’s PhD program.

**REFERENCES**

1. Vaccaro AR, Koerner JD, Radcliff KE, Oner FC, Reinhold M, Schnake KJ, Kandziora F, Fehlings MG, Dvorak MF, Aarabi B, Rajasekaran S, Schroeder GD, Kepler CK, Vialle LR (2015) AOSpine subaxial cervical spine injury classification system. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society. [PMID: 25716661]; [DOI: 10.1007/s00586-015-3831-3]

2. Magel F, Aebi M, Gertzbein SD, Harms J, Nazarian S (1994) A comprehensive classification of thoracic and lumbar injuries. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society 3:184-201 [PMID: 7866834]; [DOI: 10.1007/BF02221591]

3. Urrutia J, Zamora T, Yurac R, Campos M, Palma J, Mobarec S, Prada C (2017) An Independent Inter- and Intraobserver Agreement Evaluation of the AOSpine Subaxial Cervical Spine Injury Classification System. Spine 42:298-303. [PMID: 26630415]; [DOI: 10.1097/BRS.0000000000001302]

4. Schnake KJ, Schroeder GD, Vaccaro AR, Oner C (2017) AOSpine Classification Systems (Subaxial, Thoracolumbar). Journal of orthopaedic trauma 31 Suppl 4:S14-S23. [PMID: 28816871]; [DOI: 10.1097/BOT.0000000000000947]

5. Urrutia J, Zamora T, Campos M, Yurac R, Palma J, Mobarec S, Prada C (2016) A comparative agreement evaluation of two subaxial cervical spine injury classification systems: the AOSpine and the Allen and Ferguson schemes. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society 25:2185-2192. [PMID: 26945747]; [DOI: 10.1007/s00586-016-4498-0]

6. Silva OT, Sabba MF, Lira HI, Ghizoni E, Tedeschi H, Patel AA, Joaquim AF (2016) Evaluation of the reliability and validity of the newer AOSpine subaxial cervical injury classification (C-3 to C-7). Journal of neurosurgery Spine 25:303-308. [PMID: 27104288];
7. Patel AA, Dailey A, Brodke DS, Daubs M, Anderson PA, Hurlbert RJ, Vaccaro AR, Spine Trauma Study G (2008) Subaxial cervical spine trauma classification: the Subaxial Injury Classification system and case examples. Neurosurgical focus 25:E8. [PMID: 18980482]; [DOI: 10.3171/FOC.2008.25.11.E8]

8. Aarabi B, Oner C, Vaccaro AR, Schroeder GD, Akhtar-Danesh N (2017) Application of AOSpine Subaxial Cervical Spine Injury Classification in Simple and Complex Cases. Journal of orthopaedic trauma 31 Suppl 4:S24-S32. [PMID: 28816872]; [DOI: 10.1097/BOT.0000000000000944]

9. Vanek P New AOSpine subaxial cervical spine injury classification and its clinical usage. Rozhledy v chirurgii : mesicnik Ceskoslovenske chirurgicke spolecnosti 97:273-278 [PMID: 30442007]

10. Du JP, Fan Y, Zhang JN, Liu JJ, Meng YB, Hao DJ (2019) Early versus delayed decompression for traumatic cervical spinal cord injury: application of the AOSpine subaxial cervical spinal injury classification system to guide surgical timing. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society. [PMID: 30903293]; [DOI: 10.1007/s00586-019-05959-6]