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Introduction

Cervical Spine Trauma and Spinal Cord Injury Recommendations of WFNS Spine Committee

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In this issue of the *Neurospine*, you will find the "Cervical Spine Trauma and Spinal Cord Injury Recommendations of the World Federation of Neurosurgical Societies (WFNS) Spine Committee." Since the results of spinal cord injury (SCI) is a severe disability and a burden for society, this topic is one of the most important topics of the spinal disorders.

WFNS Spine Committee has started to create recommendations for a variety of spinal disorders. First was cervical spondylotic myelopathy and ossification of the posterior longitudinal ligament, then lumbar spinal stenosis recommendations. We then created 2 consecutive consensus meetings to extract Cervical Spine Trauma and Spinal Cord Injury recommendations from the recent literature: The first meeting was in Moscow, Russia, on 31st June 2019. The second meeting was in Peshawar, Pakistan, on 15th November 2019. A group of neurosurgeons, orthopedic surgeons, physical therapy, and rehabilitation specialists have searched for the last 10 years of literature and created statements to provide the most up-to-date solutions to this disease. Those statements were then discussed and voted to reach a consensus using Delphi technique. You will find 8 papers dedicated to prevention and management of "Cervical Spine Trauma and Spinal Cord Injury" in this special issue. In conclusion, 2 consensus meetings turned to recommendations.

There were mainly 2 groups of presentations: First "Cervical Spine Trauma," including 3 panels: (1) early management of cervical spine trauma, (2) upper cervical trauma, (3) subaxial cervical trauma. The other group was "Spinal Cord Injury." It has 5 panels: (1) early management of SCI, (2) pharmacologic and regenerative cell therapy for SCI, (3) pediatric cervical trauma, (4) SCI without radiographic abnormality (SCIWORA) outcomes of SCI, and (5) rehabilitation of SCI.

The early management of cervical spine trauma was discussed in 3 main talks: prevention of spine trauma, transportation, and immobilization of patients with cervical spine trauma, and closed reduction of cervical spinal fractures.

In a paper by Kumar et al.,[1] the burden of traumatic spine injury was searched in World Health Organization regions and country income levels. The incidence of trauma in low and middle-income countries is relatively high, while most of the publications come from high-income countries with relatively low spinal trauma incidence. The global incidence of traumatic spinal injury is 10.5 cases per 100,000 persons annually. The most frequent reasons are road traffic accidents and falls.

The very striking point is that the incidence of traumatic SCI from land transport increases in low-income countries due to the transition to motorized transport, inadequate infrastructure, and regulatory challenges. However, the incidence of low-falls in the elderly is increasing in high-income countries due to aging populations.

To prevent spine trauma, we must stress the prevention of road traffic crashes by Legislating and enforcing drink-driving laws, head restraints, seat belts, and use of child passenger restraints, setting and enforcing speed limits. The usage of motorcycles is quite common, especially in low-middle-income countries. Legislations for the usage of motorcycle helmets, unique road designs separating pedestrians and 2-wheelers from cars, graduated driver licensing systems must be applied.

Measures for preventing SCI related to falls must contain securing older people from low-falls such as adequate lighting, hand-rails, and appropriate level furniture. Besides, especially in rural areas, safe harvest equipment, using wheelbarrows instead of carrying loads on the head, can be applied.

Transportation and immobilization of patients with cervical spine trauma, especially during accidents and transportation, need more intense training of medical staff and the whole population. The best option for prehospital spine immobilization is a rigid backboard in conjunction with a hard-cervical collar and tape/straps to immobilize the entire patient. Transportation for children can have some differences. But, transport of patients with acute traumatic SCI to the definitive hospital center for SCI care should occur as soon as possible and not later than 24 hours of injury.

The closed reduction of dislocated cervical facets is still discussed. There is no evidence that closed reduction has more benefits to open reduction. If a closed reduction is attempted, it should better be done under fluoroscopy by an experienced spine surgeon in the operating room. It should be performed as early as possible. If a closed reduction is not possible, immediate anterior decompression should be performed. In the rare case that an anterior open reduction may not be achieved, a posterior open reduction must be followed. If a closed reduction in patients with decreased consciousness is attempted, prereduction magnetic resonance imaging (MRI) and open reduction should be preferred. All patients after closed reduction should be operated on for stabilization and fusion. This surgery can be with an anterior, posterior, or combined anterior and posterior approach.

In general, all locked facets should be reduced emergently. If irreducible, then an emergency intraoperative reduction with anterior/posterior fixation is recommended.

Upper cervical trauma contains unique anatomical and biomechanical constraints. Cervical computed tomography (CT) plays an integral role in diagnosis and surgical planning as the first-line study for screening the cervical spine. Measurement of anterior atlantodental interval (>3 mm) or posterior atlantodental interval (<13 mm) indicates transverse atlantal ligament (TAL) disruption and the instability of C1–2. The classification system by Mueller et al.[2] can be preferred for management planning of occipital condyle fractures. If there is no atlanto-occipital dislocation conservative treatment should be preferred in occipital condyle fractures. A stiff collar for 6 weeks will be sufficient. If condyle fracture is associated with atlanto-occipital ligamentous injury or evidence of instability (type 3 by Mueller at al.), Halo vest immobilization or occipitocervical fusion are recommended.

Atlanto-occipital dislocation is a relatively rare but fatal trauma. A condyle-C1 interval $>$ 1.5 mm establishes the diagnosis with very high sensitivity and specificity. Surgical fixation is necessary in most of cases.

CT is necessary to classify atlas fractures as stable or unstable. Axial CT slices to detect a bony avulsion of the TAL as essential criteria for instability. The recommended classification for atlas fractures is the one proposed by Gehweiler et al.[3] The majority of atlas fractures (Gehweiler types 1, 2, 3A, and 5) are stable and successfully managed conservatively by immobilization for 6 weeks with a hard-cervical collar. However, Gehweiler type 3B fractures are considered an unstable fracture. Surgery is indicated only for unstable atlas fractures.

Subaxial injury classification classification proposed by Vaccaro et al.[4] for subaxial cervical trauma is a reliable, reproducible classification, and we recommend its usage.

Children with neurological spinal cord signs and without x-ray/CT-scan abnormalities need MRI. For suspected vertebral artery injury after blunt cervical trauma, computed tomographic angiography is recommended as a screening tool.

We recommend the American Spinal Injury Association Impairment Scale (AIS) for acute neurological assessment of SCI patients. The Spinal Cord Independence Measure (SCIM III) is the best scale for assessing functional abilities and impairment in the follow-up of patients with chronic SCI. For pain evaluation, the International Spinal Cord Injury Basic Pain Data Set may be preferred.

We recommend early surgery (within 8 hours) for most cases of SCI. AIS-A patients are reported to benefit significantly from early surgery.[5] If possible, SCI patients should be treated in a spe-

cialized neurotrauma center.

Mostly complete SCI patients suffer from cardiac issues, including hypotension and bradycardia. Cardiopulmonary management of SCI should be performed to achieve neurological improvement. After studies performed in the 1990s,[6-8] and American Association of Neurological Surgeons guidelines in 2013,[9] cardiopulmonary resuscitation in SCI is necessary and we recommend the maintenance of mean arterial pressure (MAP) between 85 and 90 mmHg for the first 7 days following acute cervical SCI. In cervical or high thoracic lesions with both hypotension and bradycardia, norepinephrine with chronotropic and inotropic effects as well as vasoconstrictor properties might be required

Pharmacological therapy for acute SCI has been the subject of many experimental and clinical trials. Unfortunately, there is no pharmacological agent with high evidence level effective for acute traumatic SCI. There is no good evidence that high doses of methylprednisolone sodium succinate (MPSS) administration for acute SCI is beneficial, in correlation with its high rate of complications. In selected young patients with acute SCI, a 24-hour infusion of high dose MPSS administered within 8 hours of injury can be indicated.

We should always perform an MRI if the patient, after spinal trauma, has neurologic symptoms, but x-ray/CT findings are negative (SCIWORA). MRI findings in patients with SCIWORA correlate with symptoms and predict the neurologic outcome. In those cases, conservative treatment should be preferred instead of surgery. SCIWORA grade based on parenchymal cord injuries' MRI patterns is a useful tool for predicting outcomes.[10]

There is a vast amount of studies investigating the value of stem cells in SCI regeneration. Many sources of stem cells, scaffolds, and enhancers have been tried without apparent success. So, we could not make any recommendation regarding the efficacy of stem cell therapy in SCI treatment.

We also discussed the impact of clinical syndromes (anterior cord syndrome, central cord syndrome) on outcomes. In general, Traumatic Central Cord Syndrome (TCCS) has a good prognosis. However, factors such as older age and more severe neurological damage are associated with a lower likelihood of neurological recovery. Conservative treatment (with hemodynamic support - MAP 85–90 mmHg) remains the most common treatment for TCCS. Early surgery should be considered when there are signs of spinal instability or continuing compression of the spinal cord.

The impact of radiological findings on outcomes is another concern for outcome prediction. The presence of cervical facet dislocation on CT is suggestive of poor neurological outcome. MRI T2 sequences is a reliable technique for outcome prediction. Predictive findings on T2 sequences, including sagittal grade, length of injury, maximum canal compromise, and maximum spinal cord compression, axial grading score, provide the best and easy means to predict an outcome.

In addition to the above statements, we also discussed and created recommendations on rehabilitation for SCI, spasticity, and pain management after cord injury and functional electrical stimulation for SCI sequelae.

ACKNOWLEDGMENTS

We want to thank all WFNS Spine Committee members for their outstanding contributions to consensus meetings.

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Title: Aegean Coasts, Hisarönü, Turkey (Oil pastel)
Year: 2020
Artist: Mehmet Zileli, MD
Artist Statement:
Hisarönü is a district in the south-west part of Turkey. It is a big gulf, a charming place with wonderful nature, magnificent views and crystal-clear sea. The turquoise blue waters joining with forest costs are so attractive for wanderers, especially those with gullet yachts called blue-voyage.
The region has always been a favorite destination for my family and me in the summertime. Boating and yachting are very popular to taste the beauty of the Mediterranean sea conjugating with pine forests.
I painted this oil pastel during a boat trip with my wife to the region this summer.