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REVIEW PAPER

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Cervical spine injuries in Poland – epidemiology, divisions, and causes

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ABSTRACT

Aim. The aim of the study was to review the literature on the prevalence of cervical spine injuries divided between the level of the injury and the causes of fractures.

Material and methods. A review of Polish and foreign literature was performed. The following databases were searched: PubMed, Medline, Science Direct, Termedia, and Polish Medical Bibliography.

Literature analysis. In Poland the incidence of spinal injuries, including damage to the cord, is estimated at the level of 25–35 persons per one million of the population, half of these being cervical spine injuries. More than one in three of all spinal injuries affect the atlantoaxial and occipital area. It is estimated that axis fractures occur in up to 40% of the cases involving cervical spine injury. Odontoid fractures constitute 10–15% of all cervical spine fractures. Hangman fractures account for 20% of vertebral fractures. Cervical spine injuries more frequently occur in males than in females, and the relevant rates for males are from 1.5 to 2.7 times higher. The most common causes of cervical spine injuries include road traffic accidents, accounting for 33 to 75% of the cases, falls from heights (15–44%) and sports injuries (4–18%). Cervical spine injuries are most often diagnosed in subjects over thirty years of age. Such injuries most commonly are related to the second, fifth and sixth cervical vertebrae. On the other hand damage to the first and second cervical vertebrae is often observed in the same patients who are found with injury to lower cervical vertebrae (approx. 9% of the cases). In the group of advanced age subjects the most frequent cervical spine injuries are axial fractures and they are diagnosed in 15% of adult patients with cervical spine fractures.

Keywords. epidemiology, cervical spine, injury

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Introduction

In the structure of the cervical spine, we can distinguish two basic sections differing in terms of anatomy and range of motion. These are the atlantoaxial and occipital area as well as the section between C3 and C7 vertebrae. These sections supplement each other which enables such movements as pure lateral bending and pure rotation, as well as bending and extension of cervical spine. The joints between occipital bone, atlas (C1) and axis (C2) contain no intervertebral disks, and are characterized with a well-developed ligament system. The lower part of the spine comprises the area between C3 and C7 vertebrae containing intervertebral disks. In terms of biomechanics cervical spine can be divided into four functional parts including: atlanto-occipital joint, atlantoaxial joint, C2/C3 joint and the lower spine from C3 to C7. Each of the above sections differs in terms of morphology, kinematics, and cervical spine mobility.[1,2]

Aim of the study

The main aim of the study was to review the literature on prevalence of cervical spine injuries divided due to the level of the injury and the causes of fractures.

Method

A review of Polish and foreign literature was performed. The following databases were searched: PubMed, Medline, Science Direct, Termedia, and Polish Medical Bibliography.

Literature analysis

In Poland the incidence of spinal injuries, including damage to the cord, is estimated at the level of 25–35 persons per one million of the population, half of these being cervical spine injuries.[3] According to Kiwerski, spinal injuries occur in males 5-6 times more often than in females, and he explains that this is linked with men's greater activity in daily and professional life, and their greater propensity to engage in risky behaviours.[3-5] Likewise, Mirvis claims such injuries affect males 6 times more often,[6] Flanders – 4–6 times more often,[7] and Blacksin– 4 times more often.[4] Siemianowicz et al. carried out a retrospective assessment of 112 patients after cervical spine injury and reported male/female ratio of 2.86. The above reports were related to all spinal injuries, except for the study by Siemianowicz et al. which focused on cervical spine injuries exclusively. Interestingly, studies published in the period from 1999 to 2003 identified lower disproportion between men and women related to cervical spine injury, the relevant rates for males being 1.5 to 2.7 higher than those for females.[8] Literature review allows a conclusion that spinal injuries are most often incurred by people in the age group of 25–45.[8-12] This may be explained by the fact that this is the most productive period involving the greatest activity in personal and professional life.[8]

Occipital condylar fracture

Occipital condyle fractures are rare cranio-cervical injuries. Their incidence is 0.4–0.7% of all patients suffering trauma. The main causes of these fractures are road traffic accidents. Occipital condyle injuries are rarely diagnosed in X-rays due to overlapping shadows of the facial skull, occipital bone, and occipital condyles. Thin layer CT scan of the head with upper cervical section in patients with suspected traumatic cranio-cervical injuries is elective medical examination. Two systems of classification of occipital condyle fractures are distinguished. The classic Anderson-Montesano classification divides occipital condylar fractures into three types according to morphological criteria. Type I includes comminuted (burst) fracture without or with minimal displacement of fragments caused by axial load, Type II is a basioccipital fracture which extends to occipital condyles. These types of fractures are stable. Type III is avulsion fracture of the condyle due to avulsion of condyle by the alar ligament and is unstable. Tuli proposed the modification of the above classification, which was based on criteria of instability and damage to C0 – C1 – C2 complex in the CT scan or magnetic resonance imaging (MRI). Type I is a stable undisplaced occipital condyle fracture. Type II A is a displaced occipital condyle fracture without the instability of the C0-C1-C2 complex. Type II B is an unstable occipital condyle fracture confirmed by CT or MRI.[13-14] In 2012, a new system of classification of occipital condylar fracture was published, in which fractures were divided into unilateral or bilateral as well as with or without accompanying atlanto-occipital dislocation.[15] Since that type of fracture is rare, there is no established medical conduct. Tuli type I fracture does not require external immobilization. Type II A fracture is treated with hard collar, whereas Type II B fracture requires surgical fixation or halo vest external fixation. The time of immobilization in the halo orthosis ranges from 8 to 12 weeks. Internal occipital-spine fixation is indicated in cases of pronounced dislocation or fracture with concomitant compression of the spinal artery, spinal cord, or cranial nerves.[16-19]

Atlas fracture

The incidence of atlas vertebral fracture is 5-10% of all vertebral fractures. In 40% of cases it is accompanied by other fractures in this segment, mainly with fracture of the other vertebrae. Spinal cord injury due to the injury to the C1 vertebrae is very rare because the spinal canal is wide at this level. Landells and Petegham Atlas Fractures Classification distinguishes three types of fractures. Type I is a fracture due to extensive mechanism where fracture fissure is limited to a single arch and does not exceed the atlas equator. Type II fractures include both atlas arches and exceed its equator. The fracture mechanism is compression due to crushing of C1 arch between the occipital condyles and the lateral masses of the rotator. Jefferson burst fracture belongs to these types of fractures. Type III fracture occurs due to the action of the compression force with an asymmetric head position. This injury involves unilateral lateral mass and atlas arch. Atlas fractures are usually treated conservatively. In case the transverse ligament is injured, internal stabilization and arthrodesis should be applied.[1,19,20]

Axis fracture

More than one in three of all spinal injuries affect the atlantoaxial and occipital area.[12] Axis fracture account for 10–15% of cervical vertebral fractures in the adult population. The most common cause of injuries are falls that occur more frequently in the elderly and road traffic accidents involving young people. Axis fractures are divided depending on the affected part of the vertebra. We can distinguish the following C2 fractures: odontoid fracture, bilateral isthmus and pedicle fracture (known as Hangman's fracture), axis pedicle fracture (non-odontoid, non-hangman's).[2] Axis fractures constitute 10-15% of all cervical spine fractures in adult populations. The most common causes of injuries include falls, more frequently affecting senior citizens, as well as road traffic accidents, with particularly high rates among young people. Odontoid fractures of axis most often occur through the mechanisms of extension, and less frequently flexion.[2,21-27] Bilateral isthmus and pedicle fracture is commonly referred to as Hangman's fracture. This type of injury accounts for 20% of axis fractures. It was described for the first time in 1866 by Haughton, who identified the damage in convicts executed by hanging.[28-30] The same mechanism of hyperextension causing a fracture may occur as a result of cervical spine injury. In studies focusing on cervical spine injury, Hangman's fractures constitute the second largest group (7%), after odontoid fractures (13%).[29] The main causes of isthmus and pedicle fractures include transport accidents and falls from heights. Hangman's fracture most often occurs through the mechanisms of extension.[2] It is also assumed that the main cause of Hangman's fracture may be a direct trauma, e.g. fall onto one's face from a bicycle, or an indirect trauma such as violent jerking causing one's head to be suddenly pulled backwards during car accident.[31] Fracture of the axis vertebral body usually belongs to stable fractures. Instability is rare and arises in case of C2 / C3 subluxation or as a result of an accompanying C1 fracture. Treatment of the vertebral body fracture usually involves external fixation in the hard collar or halo vest.[1,20] Siemianowicz et al. observed the largest number of cervical fractures within C5 vertebra (24.2%), followed by C2 (20.2%).[8] The same author reported similar findings in another study where fractures of C5 represented 24.8%, and those in C2 19.3% of the cases.[10] Jankowski et al. most frequently observed odontoid fracture of the axis.[12,32-39]

Age and incidence of cervical spine injuries

Review of the literature suggests that cervical spine injuries are most often diagnosed in subjects over thirty years of age. Such injuries most commonly are related to the second, fifth and sixth cervical vertebrae. On the other hand damage to the first and second cervical vertebrae is often observed in the same patients who are found with injury to lower cervical vertebrae (approx. 9% of the cases). It is estimated that axis fractures most often occur in subjects over 70 years of age. In the group of advanced age subjects the most frequent cervical injuries are axial fractures and they are diagnosed in 15% of adult patients with cervical spine fractures. In young individuals axis fracture results from trauma involving greater force therefore injuries of this type are mainly caused by transport accidents and falls from significant heights. In older individuals it is just the opposite and the fracture may be invoked by small amount of force during a fall from a bicycle or a fall from one's own height.[24] Pankowski et al. showed that incidence of cervical fractures is the same in the age groups of 21–40 and 41–60, yet if we only take males into account cervical fractures are most common among subjects aged 21–40.[12] Siemianowicz et al. in their study reported the greatest number of patients with cervical spine fractures in the age group of 25–45, and the second most numerous was the group in the age range of 46–65 years. The above studies suggest a high rate of cervical fractures among people over 40 years of age.[10]

Causes of cervical spine injuries

According to Kiwerski, road accidents are the most common cause of cervical injuries, accounting for 33 to 75% of the cases. Other frequent causes are falls from heights (15–44%), sports injuries (4–18%), and, less often, gunshots and wounds inflicted with a sharp tool. Diving headfirst to water was identified as a cause in nearly 11% of the cases. The category of causes defined as "falls from heights" included falls from tree or ladder, falls from roof, and falls into earthworks. The group of "road accidents" included car and motorbike accidents, knock-downs and others.[3,5,8,10,12,32,40] Kiwerski claims that it is important to consider the environment in which the accident happens. Falls from heights account for 56.1% of spinal injuries in rural areas, and for 31.9% of the cases in urban areas. Accidents which are far more common in rural environments include falls from ladder, tree or roof, and those more common in urban areas involve falls from stairs, into earthworks, suicidal attempts, jumps from heights, or diving into water. In urban environment the predominant causes of injuries include road accidents (41.1%), with the most frequent car accidents and knock-downs. Motor-bike accidents are more frequent in rural areas.[5]

Kwolek et al. observed that males aged 21–40 and those over 40 are more at risk of falls from heights. Cervical injuries due to road accidents were most often identified in patients ranging in age from 21 to 50.[41] As it was mentioned before, cervical spine fractures in young people are most often induced by high amount of force, which mainly occurs during road accidents. A car accident may induce hyperextension or sudden, excessive flexion. Seat belts provide protection for the chest and stabilize the torso yet they also contribute to increased dynamics of head movements with respect to torso and consequently to a risk of cervical vertebrae dislocation.[3] Analysis of road accidents in Poland in 2013 shows that male drivers aged 25–39 were most often both perpetrators and victims of such accidents in the relevant period. Accidents by fault of pedestrians were less frequent, and they were caused mainly by older men, over 39 years of age.[42]

Neurological consequences of cervical spine injury

It is also necessary to point out neurological consequences resulting from the accidents described above, and leading to spinal injuries. It is possible to distinguish three groups: patients with symptoms of paralysis; patients with motor paresis; patients with no significant neurological impairment (including those with paraesthesia, sensory impairments, with no loss in muscle strength). According to Kiwerski, the degree of neurological impairments depends on the location of spine injury. Paralyses are found in almost 50% of the patients with cervical injury, while no significant neurological problems are observed in less than 15% of the cases. It was observed that the most severe neurological consequences were associated with thoracic spine injuries. In this case paralyses are estimated to affect 70% of the patients while no neurological complications are found in 17% of the cases. Following injuries to thoracolumbar spine 47% of the patients are found with paralyses and 28% with no neurological impairments. The least pronounced neurological consequences are associated with lumbar spine injuries (paralyses – 23%, no neurological losses – 32%).[3,5,43-48]

Summary

Cervical spine injuries are a serious problem that most often affects people at a young age. Cervical spine injuries mainly affect men both in Poland and in the world. The most common causes of spinal injuries are road traffic accidents, falls from height and sports injuries. The cervical spine fractures can lead to serious neurological consequences that can result in physical disability.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

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