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Epidemiological Analysis of Spinal Cord Injuries in a North-Western Romanian Hospital

Radu Fodor[1], Florica Voiță-Mekeres[2*], Cornel Dragos Cheregi[3], Mirela Indrieș[4], Hassan Noor[5], Nicolae Ovidiu Pop[3], Paula Marian[6], Rita Ioana Platona[7], Camelia Florentina Lascu[1], Olivia Andreea Marcu[8]

[1] Faculty of Medicine and Pharmacy, University of Oradea, Oradea, Romania.
[2] Department of Morphological Disciplines, Faculty of Medicine and Pharmacy, University of Oradea, Oradea, Romania.
[3] Department of Surgical Disciplines, Faculty of Medicine and Pharmacy, University of Oradea, Oradea, Romania.
[4] Department of Psycho-Neuroscience and Rehabilitation, Faculty of Medicine and Pharmacy, University of Oradea, Oradea, Romania.
[5] Department of Surgical Disciplines, Faculty of Medicine" Lucian Blaga", University of Sibiu, Sibiu, Romania.
[6] Department of Medical Disciplines, Faculty of Medicine and Pharmacy, University of Oradea, Oradea, Romania.
[7] Doctoral School, University of Medicine and Pharmacy "Victor Babes" Timisoara, Timisoara, Romania.
[8] Department of Preclinical Disciplines, Faculty of Medicine and Pharmacy, University of Oradea, Oradea, Romania.

***E-mail** ✉ mekeres_florina@yahoo.com
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ABSTRACT

Spinal cord injuries (SCI), especially those occurring at higher levels, frequently lead to lasting and often irreversible impairments in neurological function, often resulting from traumatic events. These injuries can compromise sensory and motor capabilities, disrupt autonomic regulation, and may even lead to death. The early and long-term stages of SCI are usually characterized by significant gastrointestinal and cardiovascular complications. Our study aimed to analyze the epidemiological and clinical characteristics of patients with high spinal cord injuries, focusing on both neurological and systemic effects. This study presents a retrospective cross-sectional epidemiological analysis of patients diagnosed with high-level spinal cord injuries and admitted to the Oradea Emergency County Clinical Hospital between 2017 and 2021. The study population consisted of 40 patients. Among them, the most common observed condition was central cervical spinal cord syndrome (35%), followed by anterior cord syndrome (22.5%). Complete spinal cord transection was relatively uncommon, recorded in 12.5% of cases. Injuries involving the brachial plexus or nerve roots were rare, occurring in only 5% of patients. The findings also showed that the prevalence and severity of these injuries were higher in male patients. Furthermore, cervical spinal cord injuries were more commonly found in older adults, especially those over 65 years of age. Central cervical cord syndrome emerged as the most common injury pattern in this cohort.

Keywords: Spinal Cord Injury, High Cervical Lesions, Autonomic Dysfunction, Gastrointestinal Complications, Complete Vs. Incomplete Injuries

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Introduction

In the general population, spinal cord injury (SCI) is often perceived primarily as a cause of motor impairment and reduced mobility. However, less recognized are the profound effects SCI has on pelvic organ function, including bowel, bladder, and sexual dysfunction [1–6].

SCI frequently results in permanent and irreversible loss of spinal cord function, most often following traumatic injury. While emerging therapies—such as cell transplantation—are under investigation, much of the preclinical work remains in the experimental stage, primarily conducted on rodent models [4, 7–9].

Anatomically, the spinal cord is a critical component of the central nervous system, responsible for transmitting motor commands from the brain to the body, relaying sensory input to the brain, and coordinating reflexes. It comprises 31 pairs of spinal nerves, organized segmentally. Damage to the spinal cord disrupts these pathways, leading to sensory deficits, motor dysfunction, autonomic dysregulation, and in severe cases, death [10–12].

Control of the gastrointestinal (GI) system relies on a delicate balance between autonomic and somatic innervation, acting through the intrinsic enteric nervous system. SCI disrupts this regulation to varying degrees depending on the location and severity of the lesion [13, 14]. Compared to the well-documented urological sequelae, the impact of SCI on bowel function has been historically under-researched [15–18]. However, more recent studies suggest that bowel dysfunction may be a greater source of distress for many SCI patients than urinary or sexual dysfunction [9, 19–21].

Gastrointestinal symptoms are common in both the acute and chronic stages of SCI, often leading to significant morbidity. One Australian study reported that GI complications accounted for approximately 11% of hospitalizations among SCI patients [22, 23]. These complications are also associated with increased rates of mental health disorders, including depression [24]. In acute SCI, symptoms may involve any part of the GI tract and can range from nausea, vomiting, and abdominal bloating to constipation and fecal incontinence [22, 25–29]. Diagnosing and managing these issues is often complicated by diminished visceral sensitivity and overlapping presentations with other abdominal conditions.

Cardiovascular dysfunction is another major consequence of SCI, especially in cases involving cervical and upper thoracic lesions. Disruption of supraspinal control over the sympathetic nervous system results in autonomic imbalance, leading to conditions such as orthostatic hypotension, bradycardia, and blunted cardiovascular responses to stress or exercise [30–35]. Morphological changes in sympathetic preganglionic neurons and increased peripheral adrenergic reactivity contribute to pathologies such as autonomic dysreflexia [36, 37]. Moreover, secondary effects of reduced mobility, such as altered metabolism and decreased physical fitness, further exacerbate cardiovascular dysfunction in this population [38–41].

Given these multifaceted complications, our study aimed to analyze the epidemiological and clinical characteristics of patients with high spinal cord injuries, focusing on both neurological and systemic impacts.

Materials and Methods

Participants

This research utilized a retrospective, cross-sectional approach to examine cases of high spinal cord injuries. The study population included all individuals admitted to the Oradea Emergency County Clinical Hospital between 2017 and 2021 with confirmed high-level spinal cord trauma.

Eligible participants were adults aged 18 years or older, regardless of sex, who had been diagnosed with upper spinal cord injuries. Diagnostic imaging using magnetic resonance imaging (MRI) of the chest and cervical spine was employed to verify each case. Individuals whose imaging results failed to confirm spinal cord injury were excluded from the final analysis.

A total of 40 patients met the inclusion criteria. Imaging confirmed their diagnoses, and all were treated within the hospital during the study period. The cohort had a median age of 55 years, with a significant male predominance—90% of the participants were men.

Instruments

Patient data were retrieved from the hospital's digital medical records system. The search was conducted using diagnostic codes from the International Classification of Diseases, 10th Revision (ICD-10). Specifically, patients were identified using codes from the S14 category, which pertains to injuries involving the nerves and spinal cord at the cervical level.

Each case flagged by this diagnostic filter was reviewed individually to confirm the presence of spinal cord injury through imaging, particularly MRI.
The ICD-10 S14 codes used for inclusion were:

- S14.0: Contusion and edema of the cervical spinal cord
- S14.1: Other and unspecified injuries of the cervical spinal cord
- S14.2: Injury of nerve root of cervical spine
- S14.3: Brachial plexus injury
- S14.4: Injury to the peripheral nerves of the neck
- S14.5: Injury of cervical sympathetic nerves
- S14.6: Other and unspecified injuries of neck nerves
- S14.10: Unspecified cervical spinal cord injury
- S14.11: Complete injury of the cervical spinal cord
- S14.12: Central spinal cord syndrome (incomplete) at cervical level
- S14.13: Other incomplete cervical spinal cord syndromes

Only those patients whose diagnosis was confirmed through imaging were included in the final dataset. After applying both inclusion and exclusion criteria, a total of 40 cases were selected for analysis.

Results

This retrospective analysis included 40 patients with confirmed high cervical spinal cord injuries. The median age was 55 years, with an interquartile range (IQR) of 38.25 to 73.75 years. The youngest patient was 18 years old, while the oldest was 85 years old.
Of the total study population, 90% (n = 36) were male, and 10% (n = 4) were female. The median age for male patients was 52 years (IQR: 38.25–73), whereas for females it was higher, at 77 years (IQR: 39.5–83).
Figure 1 illustrates a boxplot showing the age distribution by gender. Although female patients tended to be older than their male counterparts, this age difference did not reach conventional statistical significance ($p = 0.071$), as determined by the Mann-Whitney U test.

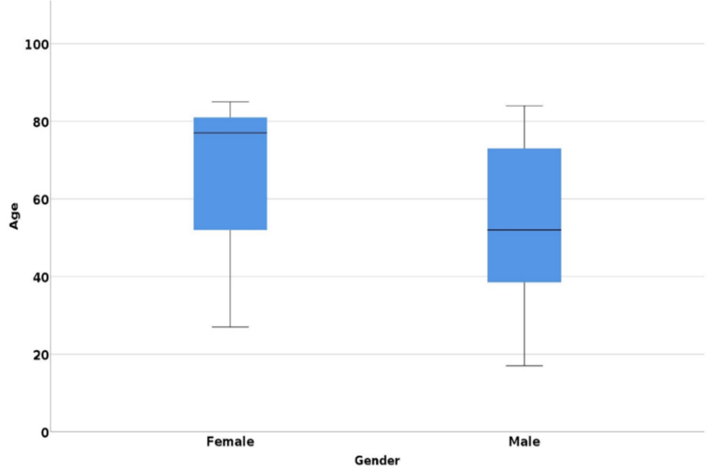

Figure 1. Boxplot of age by sex

The age distribution of spinal cord lesions reveals a relatively equal incidence between younger individuals and adults, with a noticeable increase in cervical spinal cord injuries in older age groups (**Figure 2**). The highest incidence of cervical injuries occurs in individuals aged 65 to 80 years (**Table 1**).

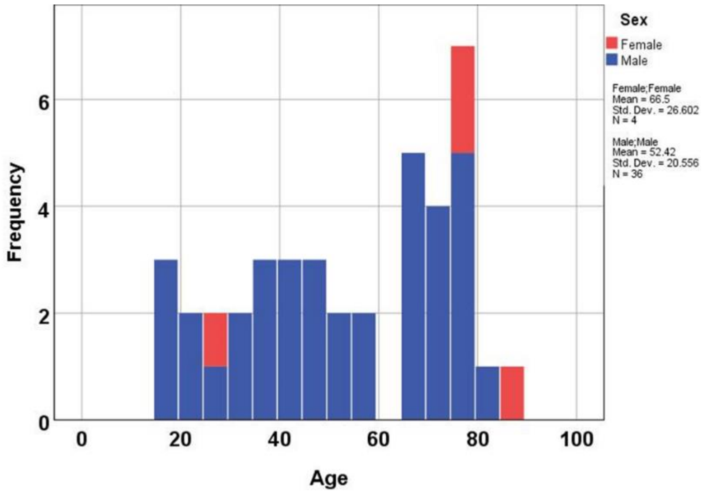

Figure 2. Histogram of cervical lesions by age and sex

Table 1. Distribution of cases by year

Year	Absolute frequency	Relative frequency	Cumulative percentage
2017	8	20.0	20.0
2018	9	22.5	42.5
2019	5	12.5	55.0
2020	11	27.5	82.5
2021	7	17.5	100.0
Total	40	100.0	

The year 2020 saw the highest number of cases, with a total of 11, while 2019 had the fewest, recording only 5 cases. Stratifying patients according to their diagnosis codes reveals that the most common code was S14.12, accounting for 35% of all diagnoses within the S14 category (**Figure 3**).

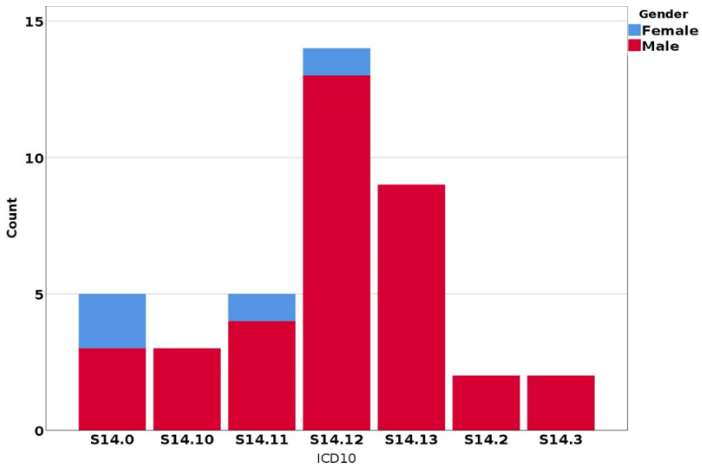

Figure 3. Distribution of diagnostic codes

The diagnosis code S14.13 ranked second in frequency, contributing to 22.5% of the total cases within the S14 block. In contrast, the least frequent diagnoses were S14.2 and S14.3, each accounting for only 5% of cases.
For female patients, lesions were most commonly linked to the diagnosis codes S14.0, S14.11, and S14.12. Male patients, on the other hand, exhibited a broader range of diagnoses, encompassing all codes within the S14 block.
Regarding the injury types (**Figure 4**), the most common was central spinal cord injury syndrome at the cervical level, representing 35% of the cases. This was followed by anterior spinal cord injury syndrome at 22.5%. Complete spinal cord injuries were observed in 12.5% of the patients, while lesions involving the brachial plexus or nerve roots were the least frequent, found in only 5% of cases.

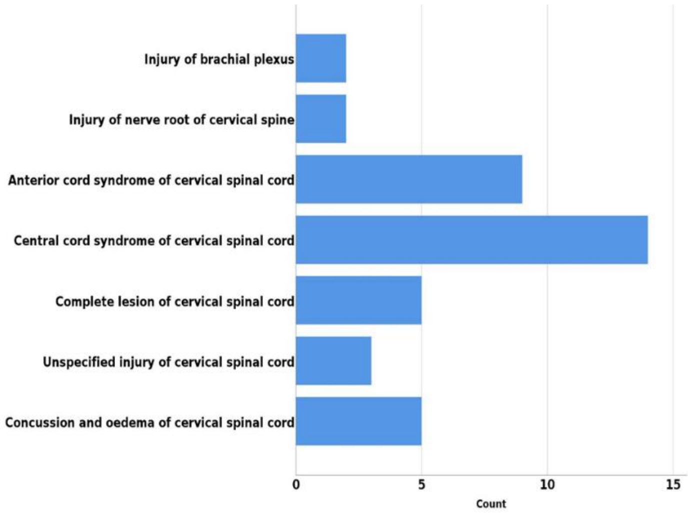

Figure 4. Distribution by type of injury

In terms of injury severity, the majority of spinal cord injuries were incomplete (65%), with only 12.5% classified as complete cord injuries (**Table 2**). Mild lesions, such as edema or colitis, were observed in just 12.5% of the cases, while lesions involving the nerve roots or plexus were the least frequent, occurring in only 10% of patients.

Table 2. Severity of spinal cord injuries

Type of injury	Absolute frequency	Relative frequency	Cumulative percentage
Concussion/edema	5	12.5	12.5
Nerve root/plexus	4	10.0	22.5
Incomplete	26	65.0	87.5
Complete	5	12.5	100.0
Total	40	100.0	

Discussion

In this study, the distribution of injury severity followed a Gaussian pattern, with moderate injuries being the most prevalent. Severe injuries were more commonly observed in male patients, while mild injuries were comparatively rare.

Our findings align with those of Lowery *et al.* [42], who reported a male predominance (70.9%) in cervical spinal cord injuries in a study of over 30,000 patients. This gender disparity is also evident in our cohort, where a higher incidence of cervical spinal cord injuries was found in males. Furthermore, Lowery *et al.* [42] documented an increase in the incidence of these injuries with age, particularly in those aged 65-85 years. Similarly, our study and other literature sources confirm a rise in cervical spinal cord injuries among individuals over 65 years.

The Nexus cohort, a comprehensive epidemiological database, supports the observation that cervical spinal cord injuries occur more frequently in males and that their incidence increases progressively with age, especially in the 65-85 years age group.

In terms of injury severity, our study found that 12.5% of patients had complete spinal cord injuries, while the majority had incomplete injuries. This pattern of incomplete injuries being more common has been corroborated by Hu *et al.* [43] in a study with over 2,000 patients, reinforcing the trend of incomplete spinal cord lesions being predominant.

A limitation of this study is the reliance on the hospital's administrative database, which uses ICD-10 coding. This system lacks detailed information on the exact location of the injuries, making it difficult to categorize the lesions accurately. While we were able to identify trends in the overall incidence of spinal cord injuries, finer details about lesion specifics were not available.

Conclusion

Our study reveals that high cervical spinal cord injuries are more frequent in males and show a significant increase with age, especially in individuals aged 65 and older. The most common type of injury observed was central spinal cord injury syndrome at the cervical level (an incomplete spinal cord injury), with moderate injuries being the most frequent. Minor and complete injuries were less common.

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Ethics Statement: None

References

1. McKay WB, Sweatman WM, Field-Fote EC. The experience of spasticity after spinal cord injury: perceived characteristics and impact on daily life. Spinal Cord. 2018;56(5):478-86.
2. Chen J, Weidner N, Puttagunta R. The Impact of Activity-Based Interventions on Neuropathic Pain in Experimental Spinal Cord Injury. Cells. 2022;11(19):3087.
3. Voiță-Mekeres F, Buhaș CL, Mekeres GM, Tudoran C, Racovita M, Faur CI, et al. Mekeres' Psychosocial Internalization Scale: A Scale for the Evaluation of Aesthetic Prejudice in Victims of Accidents and Violence. InHealthcare 2021 Nov (Vol. 9, No. 11, p. 1440). Multidisciplinary Digital Publishing Institute.
4. Mahmassani D, Bachir R, El Sayed M. Patterns and Predictors of Firearm-related Spinal Cord Injuries in Adult Trauma Patients. West J Emerg Med. 2021;22(2):270-7.
5. Hou S, Rabchevsky AG. Autonomic consequences of spinal cord injury. Compr Physiol. 2014;4(4):1419-53.
6. Hubscher CH, Wyles J, Gallahar A, Johnson K, Willhite A, Harkema SJ, et al. Effect of Different Forms of Activity-Based Recovery Training on Bladder, Bowel, and Sexual Function After Spinal Cord Injury. Arch Phys Med Rehabil. 2021;102(5):865-73.
7. Reshamwala R, Eindorf T, Shah M, Smyth G, Shelper T, St John J, et al. Induction of Complete Transection-Type Spinal Cord Injury in Mice. J Vis Exp. 2020;(159):e61131.
8. Salehi-Pourmehr H, Rahbarghazi R, Mahmoudi J, Roshangar L, Chapple CR, Hajebrahimi S, et al. Intra-bladder wall transplantation of bone marrow mesenchymal stem cells improved urinary bladder dysfunction following spinal cord injury. Life Sci. 2019;221:20-8.
9. Gondim FA, De Oliveira GR, Thomas FP. Upper gastrointestinal motility changes following spinal cord injury. Neurogastroenterol Motil. 2010;22(1):2-6.
10. Perez NE, Godbole NP, Amin K, Syan R, Gater Jr DR. Neurogenic bladder physiology, pathogenesis, and management after spinal cord injury. J Pers Med. 2022;12(6):968.
11. Afshari K, Momeni Roudsari N, Lashgari NA, Haddadi NS, Haj-Mirzaian A, Hassan Nejad M, et al. Antibiotics with therapeutic effects on spinal cord injury: a review. Fundam Clin Pharmacol. 2021;35(2):277-304.
12. Guest J, Datta N, Jimsheleishvili G, Gater DR Jr. Pathophysiology, Classification and Comorbidities after Traumatic Spinal Cord Injury. J Pers Med. 2022;12(7):1126.
13. Bigford GE, Szeto A, Darr AJ, Illiano P, Zambrano R, Mendez AJ, et al. Characterization of Gastrointestinal Hormone Dysfunction and Metabolic Pathophysiology in Experimental Spinal Cord Injury. J Neurotrauma. 2023;40(9-10):981-98.
14. Herrera J, Bockhorst K, Bhattarai D, Uray K. Gastrointestinal vascular permeability changes following spinal cord injury. Neurogastroenterol Motil. 2020;32(7):e13834.
15. Faris M, Utomo B, Fauzi AA. ACTH4-10PRO8-GLY9-PRO10 improves Neutrophil profile in spinal cord injury of rat models. J Adv Pharm Educ Res. 2021;11(2):61-5.
16. Dykstra DD. Botulinum toxin in the management of bowel and bladder function in spinal cord injury and other neurologic disorders. Phys Med Rehabil Clin N Am. 2003;14(4):793-804.
17. Ahuja CS, Wilson JR, Nori S, Kotter MRN, Druschel C, Curt A, et al. Traumatic spinal cord injury. Nat Rev Dis Primers. 2017;3(1):17018.

18. Qi Z, Middleton JW, Malcolm A. Bowel Dysfunction in Spinal Cord Injury. Curr Gastroenterol Rep. 2018;20(10):47.
19. Craven C, Hitzig SL, Mittmann N. Impact of impairment and secondary health conditions on health preference among Canadians with chronic spinal cord injury. J Spinal Cord Med. 2012;35(5):361-70.
20. Tamburella F, Princi AA, Piermaria J, Lorusso M, Scivoletto G, Masciullo M, et al. Neurogenic Bowel Dysfunction Changes after Osteopathic Care in Individuals with Spinal Cord Injuries: A Preliminary Randomized Controlled Trial. Healthcare (Basel). 2022;10(2):210.
21. Park SE, Elliott S, Noonan VK, Thorogood NP, Fallah N, Aludino A, et al. Impact of the bladder, bowel and sexual dysfunction on the health status of people with thoracolumbar spinal cord injuries living in the community. J Spinal Cord Med. 2017;40(5):548-59.
22. Enck P, Greving I, Klosterhalfen S, Wietek B. Upper and lower gastrointestinal motor and sensory dysfunction after human spinal cord injury. Prog Brain Res. 2006;152:373-84.
23. Lascu CF, Buhaș CL, Mekeres GM, Bulzan M, Boț RB, Căiță GA, et al. Advantages and Limitations in the Evaluation of the Neurological and Functional Deficit in Patients with Spinal Cord Injuries. Clin Pract. 2022;13(1):14-21.
24. Tudoran M, Tudoran C, Ciocarlie T, Giurgi-Oncu C. Aspects of diastolic dysfunction in patients with new and recurrent depression. Plos One. 2022;15(1):e0228449.
25. Albert TJ, Levine MJ, Balderston RA, Cotler JM. Gastrointestinal complications in spinal cord injury. Spine. 1991;16:S522-5.
26. Mekeres GM, Voiţă-Mekereş F, Tudoran C, Buhaş CL, Tudoran M, Racoviţă M, et al. Predictors for Estimating Scars' Internalization in Victims with Post-Traumatic Scars versus Patients with Postsurgical Scars. InHealthcare 2022 Mar 16 (Vol. 10, No. 3, p. 550). MDPI.
27. Stanghellini V, Chan FK, Hasler WL, Malagelada JR, Suzuki H, Tack J, et al. Gastroduodenal disorders. Gastroenterology. 2016;150(6):1380-92.
28. Deng Y, Dong Y, Liu Y, Zhang Q, Guan X, Chen X, et al. A systematic review of clinical studies on electrical stimulation therapy for patients with neurogenic bowel dysfunction after spinal cord injury. Medicine. 2018;97(41).
29. Xu P, Guo S, Xie Y, Liu Z, Liu C, Zhang X, et al. Effects of highly selective sympathectomy on neurogenic bowel dysfunction in spinal cord injury rats. Sci Rep. 2021;11(1):15892.
30. Phillips AA, Krassioukov AV. Contemporary cardiovascular concerns after spinal cord injury: mechanisms, maladaptations, and management. J Neurotrauma. 2015;32(24):1927-42.
31. Teasell RW, Arnold JM, Krassioukov A, Delaney GA. Cardiovascular consequences of loss of supraspinal control of the sympathetic nervous system after spinal cord injury. Arch Phys Med Rehabil. 2000;81(4):506-16.
32. Tudoran M, Tudoran C, Ciocarlie T, Pop GN, Berceanu-Vaduva MM, Velimirovici DE, et al. Aspects of Heart Failure in Patients with Ischemic Heart Disease after Percutaneous Coronary Revascularization with Polymer-coated Drug-Eluting Stents versus Bare-Metal Stents. Mater Plast. 2019;56(1):37-40.
33. Podell J, Pergakis M, Yang S, Felix R, Parikh G, Chen H, et al. Leveraging continuous vital sign measurements for real-time assessment of autonomic nervous system dysfunction after brain injury: a narrative review of current and future applications. Neurocrit Care. 2022;37(Suppl 2):206-19.
34. Oşvar FN, Raţiu AC, Voiţă-Mekereş F, Voiţă GF, Bonţea MG, Racoviţă M, et al. Cardiac axis evaluation as a screening method for detecting cardiac abnormalities in the first trimester of pregnancy. Rom J Morphol Embryol. 2020;61(1):137.
35. Omer AE, Muddathir AR, Eltayeb LB. Measurement of Fibrin Degradation Products (FDPs) among Patients with Cardiovascular Diseases: A significant Target for Prognosis. J Biochem Technol. 2021;12(4):23-8.
36. Krassioukov AV, Bunge RP, Pucket WR, Bygrave MA. The changes in human spinal sympathetic preganglionic neurons after spinal cord injury. Spinal cord. 1999;37(1):6-13.
37. Arnold JM, Feng QP, Delaney GA, Teasell RW. Autonomic dysreflexia in tetraplegic patients: evidence for α-adrenoceptor hyper-responsiveness. Clin Auton Res. 1995;5:267-70.
38. Lee AH, Phillips AA, Krassioukov AV. Increased central arterial stiffness after spinal cord injury: contributing factors, implications, and possible interventions. J Neurotrauma. 2017;34(6):1129-40.
39. Bauman W, Korsten M, Radulovic M, Schilero G, Wech J, Spungen A. 31st g. Heiner sells lectureship: secondary medical consequences of spinal cord injury. Top Spinal Cord Inj Rehabil. 2012;18(4):354-78.

40. Bauman WA, Spungen AM. Metabolic changes in persons after spinal cord injury. Phys Med Rehabil Clin N Am. 2000;11(1):109-40.
41. Tudoran C, Tudoran M, Vlad M, Balas M, Pop GN, Parv F. Echocardiographic evolution of pulmonary hypertension in female patients with hyperthyroidism. Anatol J Cardiol. 2018;20(3):174-81.
42. Lowery DW, Wald MM, Browne BJ, Tigges S, Hoffman JR, Mower WR, et al. Epidemiology of cervical spine injury victims. Ann Emerg Med. 2001;38(1):12-6.
43. Hu R, Mustard CA, Burns C. Epidemiology of incident spinal fracture in a complete population. Spine. 1996;21(4):492-9.