of clinical presentation and diagnosis of mucopolysaccharidosis IVA. Mol. Genet. Metab. 2013; 110: 54 – 64.
24. Muhlebach M.S., Wooten W. [et al.]. Respiratory manifestations in Mucopolysaccharidosis. Paediatr. Respir. Rev. 2011; 12: 133 - 138.
25. Martin R., Beck M. [et al.]. Recognition and diagnosis of mucopolysaccharidosis II (Hunter syndrome). Pediatrics. 2008; 121 (2): 377 - 386.
26. Meyer A, Kossow K. [et al.] Scoring evaluation of the natural course of mucopolysaccharidosis type IIIA (Sanfilippo syndrome type A). Pediatrics. 2007; 120 (5): 1255 - 1261.
27. Tandon W., Williamson J.B. [et al.]. Spinal problems in mucopolysaccharidosis I (Hurler syndrome). J. Bone Joint. Surg. Br. 1996; 78(6): 938 - 944.
28. Young I.D., Harper P.S. [et al.] The natural history of the severe form of Hunter's syndrome: a study based on 52 cases. Dev. Med. Child. Neurol. 1983; 25(4): 481 – 489.
29. Nemes A., Timmermans R.G.M., Wilson J.H. [et al.] The mild form of mucopolysaccharidosis type I (Scheie syndrome) is associated with increased ascending aortic stiffness. Heart Vessels. 2008; 23: 108.
30. Walker P.P., Rose E. [et al.]. Upper airways abnormalities and tracheal problems in Morquio's disease. Thorax, 2003; 58: 458 - 459.
31. Vasilev F., Sukhomyasova A., Otomo T. Mucopolysaccharidosis-Plus Syndrome. International Journal of Molecular Sciences. 2020; 21 (2): 421.
32. McCafferty E. H., Scott L. J. Vestronidase alfa: a review in mucopolysaccharidosis VII. BioDrugs. 2019; 33 (2): 233-240.
33. Wraith J.E., Jones S. Mucopolysaccharidosis type VI. Pediatr. Endocrinol. Rev. 2014; 12: 102 - 106.

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ISOLATED SPINAL CORD INJURY IN CHILDREN - SCIWORA SYNDROME

The relevance of the isolated injury of the spinal cord in children is due to the severity of damage, which often leads to unsatisfactory results of the therapy. Objective. Analyse and legend in the form of an overview of literature Scientific products. Materials and methods. Scientific publications to write a review of literature were obtained from the PabMed, eLIBRARY, CYBERLENINKA. Literature sources were searched for the following keywords: isolated spinal cord injury, SCIWORA syndrome, SCIWONA syndrome, SCIWORET syndrome. Results and discussion. SCIWORA syndrome diagnostic frequency among children who have been injured by the postcase is from 3% to 6% of cases. Initially, this syndrome is to meet fishing up to 8 years of age, boys predominate among the victims. Most often other parts of the spinal cord are affected cervical. Lead to the development of SCIWORA syndrome car accident. The main clinical symptoms of diseases are weakness in the limbs, the feeling of the passage of the "electric current" on the spine, various neurological disorders: from a minor deficit to the complete absence of motor and sensitive functions. The severity of neurological coupling will determine the scale of F. Frankel and the ASIA scale. The leading diagnostic method is the magnetic-reserved tomography. The patient's treatment with SCIWORA syndrome conducts conservative and operational methods, while the standard of therapy is currently not developed. The most important projection criteria during SCIWORA syndrome is the initial neurological status of patients after injury and results magnetic resonance tomography. Children with the lightest in neurologically delicacy are restored completely. Conclusion. SCIWORA syndrome problem keeping your apartment. The necessary developed uniform approaches and standards in the tactics of the treatment of children with this melting pathology.

Keywords: children, isolated spinal cord injury, SCIWORA syndrome, literature review.

Introduction. The isolated injury of the spinal cord in children is an actual problem of modern traumatology and neurosurgery [26, 31, 32]. The relevance is due to the severity of damage gained by children, which often leads to unsatisfactory results of the therapy [22, 37]. In the domestic medical literature devoted to the spinal-spinal injury in children, aspects of SCIWORA syndrome - isolated spinal cord injury without related damage to the bone structures of vertebrals and intervertebral discs are not fully reflected.

Objective. Analyze the main domestic and foreign publications dedicated to isolated spinal cord injuries in children - SCIWORA syndrome. The obtained information is recycled and submit in the form of a review of literature.

Material and methods. Scientific publications To write a review of literature on the topic "Isolated spinal cord injury in children - SCIWORA syndrome" were obtained from modern PubMed, eLIBRARY, CYBERLENINNKA databases. A total of 42 scientific articles were used, which reflect the most actual problems and aspects of the topic studied. Domestic literary sources used - 4 (9.53%), foreign - 38 (90.47%).

The search for literature sources was carried out according to the following keywords: isolated spinal cord injury in children, SCIWORA syndrome, SCIWONA syndrome, SCIWORET syndrome.

Results and discussion. One of the first authors who reported the damage to the spinal cord in children without X-ray confirmations from the vertebrae and the spine binder, was S. Lloyd, published on this topic in 1971 [16]. The decade later, at the beginning of the 80s of the last century, the american authors of D. Peng et al., presented the medical community to the publication, in which 20-year-old clinical experience was set forth on a scientific basis about 24 children without radiation (x-ray and computer-tomographic (CT)) symptoms characteristic of the injuries of the vertebrae. This state of the authors have been defined as «Spinal Cord Injury Without Radiographic Abnormality» (abbreviated: SCIWORA) [21].

With a wide introduction into the clinical practice of magnetic resonance tomography (MRI), when it became possible to diagnose even minor damage to the spinal cord, a new term was proposed – SCIWONA (Spinal Cord Injury Worth Neuroimaging Abnormality). This abbreviation describes the clinical situations of damage to the spinal cord in children and adolescents unchanged on the MRI grams of the spine and the spinal cord [42]. In cases where the damage to the spinal cord is diagnosed in the absence of reliable history data on injuries, the term SCIWORET is used (Spinal Cord Injury Worth Radiographic Evidence of Trauma) [10].

In English-speaking medical literature, when describing the isolated spinal cord injuries in children, the term "SCIWORA" was the greatest distribution. Pathological conditions, regarded as "SSIWONA" and "SCIWORET" in pediatric patients describe significantly less often [41]. Scientific publications in foreign literature dedicated to SCIWORA syndrome sufficiently, which cannot be said about articles in domestic sources [4]. Even in the regulatory medical activities of documents, in relation to the spinal-spinal inju-

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ry, there are no recommendations for the diagnosis and treatment of SCIWORA. So, A.K. Dulaev et al., Analyzed all the domestic regulatory documentation available by 2021, the practical guidelines and clinical recommendations approved by the Ministry of Health of the Russian Federation indicate that they do not consider the provision of medical care to patients with this syndrome [2].

It is now known that the incidence of SCIWORA among children with various types of spinal injuries ranges from 3% [13] to 38% [38] of cases. In children and adolescents who are hospitalized in neurosurgical departments, the frequency of diagnosing this condition is in a wider range: from 3% [1] to 64% [4] of clinical observations. Despite the fact that in modern medical literature, especially foreign, there are a sufficient number of publications about the SCIWORA syndrome, the frequency of its diagnosis depends, according to D. Pang et al. "from the awareness of doctors of the local medical community about this condition" [20].

Most often, SCIWORA syndrome is diagnosed in children under 8–9 years of age [18, 26]. At the same time, cases have been published in the literature when adolescents predominate in the group of studied patients with this syndrome [34]. The main injury mechanisms leading to this type of injury are situations in which hyperextension, hyperflexion, and spinal distraction occur almost simultaneously [17, 19, 22]. Typically, such sharp and high-amplitude movements of the head and torso of patients occur during traffic accidents, as well as during sports training or competitions in such sports as wrestling, gymnastics, acrobatics, equestrianism [20, 31, 40]. At the same time, the literature describes clinical cases of the development of the SCIWORA syndrome in children with falls from a height of about 50 cm [32]. According to J. Knox, 87% of pediatric patients with spinal cord injury are diagnosed with various concomitant injuries of the skull, chest, limbs, pelvis, and internal organs [15].

Preferential damage to the spinal cord than to the vertebral bodies in young children is primarily due to the anatomical and physiological features of the growing spine [26, 30]. These include greater elasticity and extensibility of the muscular-ligamentous-capsular apparatus of the children's spine than of the spinal cord [7, 27], hyperhydrophilicity of the intervertebral discs [22], less intense blood supply to the spinal cord than in adults [39], structural features of the vertebrae (age-related underdevelopment of the uncinate (lunate) processes and more horizontal orientation of the articular processes at the cervical level) [7, 23]. In the development of the SCIWORA syndrome, the physiological disproportion in the size of the head and body of young children [40], the weakness of their paravertebral muscles [24] is of great importance. Almost all authors studying SCIWORA agree that the cervical level of the spine is affected more often than the thoracic and lumbar ones [18, 28]. So, according to T. Carroll et al. in the structure of injuries, the cervical region accounts for up to 87% of injuries, thoracic - 9.5%, lumbar - 1.5%, both thoracic and lumbar levels - 2% [31]. With regard to injuries of the cervical spine in children of younger age groups (up to 8-9 years old), pathology is more often diagnosed at the level of the cranio-cervical junction, in adolescent patients - at the subaxial level [15, 20]. At the same time, scientific articles were published that provide data from cohort studies on the predominant diagnosis of SCIWORA syndrome at the thoracic level of the spinal canal [23, 37]. Thus, the Chinese authors Z. Zou et al. reported that among 140 children with this syndrome, in 77% of cases, the pathology was localized at the thoracic level [22].

Most of the authors in their publications present gender differences in patients with this pathology in a ratio of 2:1, with a predominance in boys and young men [26, 29]. Information has also been published in the literature that the incidence of SCIWORA syndrome is 2.5:1.0 in favor of females [22].

The leading clinical symptoms of the disease are transient weakness and paresthesia in the extremities, a feeling of “electric current passing” along the spine [3, 21, 32]. In children of younger age groups, parents often indicate weakness in the legs when walking [32]. Vertebrogenic pain syndrome and breathing difficulties of the type of "post-traumatic apnea" are not recorded in all victims [4]. During a clinical examination, patients are often diagnosed with hypertonicity of the extensor muscles of the spine [25], episodes of encopresis and enuresis [32].

Researchers involved in the SCIWORA problem diagnose various conditions in patients: from a slight neurological deficit (type D, according to the F. Frankel scale) to a complete absence of motor and sensory functions (type A, according to the F. Frankel scale) [5, 32, 37] . In addition to the F. Frankel scale, the American Spinal Injury Association (ASIA) scale is used in clinical practice to standardize the examination and make a neurological conclusion in patients with clinical manifestations of SCIWORA [1, 33].

Since the CT of the spine does not fully appreciate the state of the spinal cord, MRI is given a leading role in the diagnosis of SCIWORA [1, 26, 31]. It is this procedure that allows you to investigate the contents of the spine channel, and with no other method of neurovalization to determine the fact and nature of damage to the spinal cord, if any. In most cases, during the diagnosis of SCIWORA, both research methods - CT and MRI [14, 32] are used [14, 32]. Some researchers pre-conduct X-ray of the injured spine [5, 25, 37]. It is important to note that the MRI criteria for the damage to the spinal cord in children with a diagnosis of SCIWORA are often detected during testing research, while this diagnostic procedure performed immediately after injury may not fix the symptoms of pathology [28, 31]. Japanese authors J. Ouchida et al. particularly emphasize that "... a delayed MRI study may represent extremely important information on the state of the spinal cord after the acute injury of the spine." This conclusion by the authors was made on the basis of three series of MRI-visualization of the spine in 68 patients with a diagnosis of SCIWORA: at the time of entering the hospital after the injury is received, after 2 days and after 2 weeks from the moment of hospitalization [11].

Treatment of children with a diagnosis of SCIWORA is carried out both conservative and operational methods, while the generally recognized standard of therapy is currently not developed [26]. All patients are attributed to compliance with the strict bed regime with immobilization of the injured spine, most often cervical, orthopedic products [5, 14, 32, 37]. Physiotherapeutic procedures are also used in the therapy of the spinal-spindy injury [25, 32, 37]. Medical therapy is to prescribe to patients with drugs from the corticosteroid group [31]. So, S. Sharma et al. [6] and S.P. Mohanty et al. [10] using the intravenous administration of methylprednisolone for these purposes in the first 48 hours of finding patients in the hospital. The main indication for surgical treatment of patients with SCIWORA syndrome is the lack of positive dynamics during neurological symptoms or its progression [9]. Most often, the volume of surgical intervention is to decompression of the injured spinal cord department by means of laminectomy [14]. Chinese authors C. Qi et al. they consider the optimal period of operational intervention for the first 3 days, which have passed after injury. In their opinion, based on the experience of surpassing 57 patients with SCIWORA syndrome, the quantity of time on op-

erational intervention is postponed, the worse the forecast [36].

According to T. Carroll et al., who analyzed 31 scientific articles, which presented a generalized experience in the diagnosis and treatment of 433 children diagnosed with SCIWORA, spinal immobilization and steroid therapy were used in 62.84% and 33.88% of injured children, respectively. Surgical treatment was subjected to 3.28% of the victims [31].

In generally, the majority of patients with SCIWORA syndrome register a marked improvement in neurological status during therapy. The main reason for choosing conservative therapy in the treatment of this category of patients is the absence of damage to the vertebrae, requiring their reposition and stabilization [26]. The two most important predictors of prognosis during SCIWORA are baseline neurological status and MRI findings [8, 33]. In children with complete spinal cord injury, the outcome of the treatment is unfavorable in terms of regression of neurological symptoms. Pediatric patients with a mild initial neurological deficit have every chance of a full recovery [12].

In the long-term period, the prognosis for health and life in children who have had a moderate severity of clinical manifestations of the SCIWORA condition is, as a rule, favorable [31, 26]. At the same time, they may reacquire clinical symptoms similar to the original symptoms of SCIWORA. Eight such clinical observations, which developed on average 2 weeks after the discharge of patients from hospitals, are reported in their article by D. Pang et al. all children repeatedly injured their spine during traumatic sports (4 children) or as a result of car injuries (4 children) [20]. Turkish authors N. Yalcin et al. cite data that neuromuscular scoliosis developed in 4 children, on average 17 months after undergoing SCIWORA, requiring subsequent surgical correction [35].

Conclusion. Various aspects of the spinal cord injury in children continue to maintain their relevance. During the analysis of modern scientific publications on the problem of SCIWORA, data and new facts were established to expand the horizons of specialist doctors providing specialized medical care in this category of patients. Thus, the frequency of occurrence of this type of damage in children was found out, it is shown in which age category patients are most often traumatized, the main mechanisms of injury and spinal cord levels affecting most often. In the literary review, the anatomy-physiological features of the growing spine, which determine the preemptive defeat of the spinal cord in children in comparison with damage to the bodies of the vertebrae. The clinical symptoms of SCIWORA syndrome, the most informative methods of radiation visualization of injuries obtained by children are described in detail. Treatment of children with isolated injury to the patients's spinal cord is carried out both conservative and operational methods, while all researchers, articles of which are analyzed and are given in the present literary review, noted the absence of uniform, generally accepted algorithms used during the course of therapy. The forecast for the health and life of children undergoing symptoms of SCIWORA syndrome is usually favorable. Those patients who had an initial light neurological deficit have every chance of complete recovery.

References

1. Novoselova I.N., Melnikova I.A., Ponina I.V. [et al.]. Oshibki diagnostiki izolirovannogo povrezhdeniya spinnogo mozga u detej [Diagnostic errors insulated damage to the spinal cord in children]. Vestnik vosstanovitel'noj mediciny [Herald of recovery medicine. 2021; 20 (2): 109-117 (In Russ.).] doi: 10.38025/2078-1962-2021-20-2-109-117

2. Dulaev A.K., Kutyanov D.I., Iskrovskiy S.V. [et al.]. Rekomendatel'naya baza po okazaniyu specializirovannoj medicinskoj pomoshchi pacientam s pozvonochno-spinnomozgovoj travmoj v Rossii: obzor predmetnogo polya [Recommendation base for the provision of specialized medical care to patients with spinal spinal injury in Russia: an object of the subject field]. Hirurgiya pozvonochnika [Spinal surgery]. 2021; 18(4): 41-54 (In Russ.).] doi: 10.14531/ss2021.4.41-54

3. Sitko L.A., Vorobyev A.M. Klinicheskie i MRT osobennosti stabil'nyh povrezhdenij pozvonochnika i spinnogo mozga u detej [Clinical and MRI Features of stable damage to the spine and spinal cord in children]. Medicina v Kuzbasse [Medicine in Kuzbass]. 2015; 14 (1): 57-63 (In Russ.).]

4. Larkin I.I., Lar'kin V.I., Preobrazhenskiy A.S. Travmaticheskie povrezhdeniya spinnogo mozga u detej [Traumatic damage to the spinal cord in children. Polytrauma. 4: 46-50 (In Russ.).]

5. Nagasawa H, Ishikawa K, Takahashi R [et al.]. A case of real spinal cord injury without radiologic abnormality in a pediatric patient with spinal cord concussion. Spinal Cord Ser Cases. 2017; 3: 17051. doi: 10.1038/scsandc.2017.51

6. Sharma S, Singh M, Wani I.H. [et al.]. Adult Spinal Cord Injury without Radiographic Abnormalities (SCIWORA): Clinical and Radiological Correlations. J Clin Med Res. 2009; 3 (1) 165-172. doi: 10.4021/jocmr2009.08.1256

7. Basu S. Spinal injuries in children. Front Neurol. 2012; 3: 96. doi: 10.3389/fneur.20212.00096

8. Machino M, Yukawa Y, Ito K [et al.] Can magnetic resonance imaging reflect the prognosis in patients of cervical spinal cord injury without radiographic abnormality? Spine. 2011; 36 (24): 1568-1572. doi: 10.1097/BRS.0b013e31821273c0

9. Martinez-Perez R., Munarriz P.M., Paredes I. [et al.]. Cervical Spinal Cord Injury without Computed Tomography Evidence of Trauma: Magnetic Resonance Imaging Prognostic Factors. World Neurosurg. 2017; 9: 192-199. doi: 10.1016/j.wneu.2016.12.05

10. Mohanty S.P., Bhat N.S., Singh K.A. [et al.] Cervical spinal cord injuries without radiographic evidence of trauma: A prospective study. Spinal Cord. 2013; 51 (11): 815-818. doi: 10.1038/sc.2013.87

11. Ouchida O, Yukawa Y., Ito K. [et al.]. Delayed Magnetic Resonanse Imaging in Patients With Cervical Spinal Cord Injury Without Radiographic Abnormality. Spine. 2016; 41 (16): 981-986. doi: 10.1097/BRS.0000000000001505

12. Liu Q, Liu Q, Zhao J [et al.] Early MRI finding in adult spinal cord injury without radiologic abnormalities does not correlate with the neurological outcome: a retrospective study. Spinal Cord. 2015; 53 (10): 750–753. doi: 10.1038/sc.2015.45

13. R. Compangnon, E. Ferrero, J. Leroux [et al.] // Epidemiology of spinal fractures in children: Cross-sectional study. Orthop Traumatol Surg Res. 2020; 106 (7): 1245-1249. doi: 10.1016/j.otsr.2020.06.015

14. Fiachi P, Severino M, Ravegnani G.M. [et al.]. Idiopathic Cervical Hematomyelia in a Infant: Spinal Cord Injury without Radiographic Abnormality Caused by a Trivial Trauma? Case Report and Review of the Literature. World Neurosurg. 2016; 90. – P. 38-40. doi: 10.1016/j.wneu.2016.01.094

15. Knox J. Epidemiology of spinal cord injury without radiographic abnormality in children: a nationwide perspective. J Child Orthop. 2016; 10 (3): 255-260. doi: 10.1007/s11832-016-0740-x

16. Lloyd S. Fracture dislocation of he spine. Med Rec. 1971; 1: 465-470.

17. Freygang V, Butz K, Seebauer C.T. [et al.] Management and Mid-Term Outcome After «Real SCIWORA» in Children and Adolescents. Global Spine J. 2021. doi: 10.1177/2192568220979131

18. Brauge D, Plas B, Vinchon M [et al.] Multicenter study of 37 pediatric patients with SCIWORA or other spinal cord injury without associated bone lesion. Orthop Traumatol Surg Res. 2020; 106 (1): 167-171. doi: 10.1016/j.otsr.2019.10.006

19. Olzan Izma M.K., Zulkhanain I, Ramli B. Spinal Cord Injury Without Radiological Abnormality (SCIWORA). Med J Malaysia. 2003; 58 (1): 105-110

20. Pang D., Eibach S. Spinal Cord Injury Without Radiographic Abnormality (SCIWORA) in Children. In book: Textbook of Pediatric Neurosurgery. 2017; 1-39. doi: 10.1007978-3-319-31512-6-134-1

21. Pang D., Wilberger J.E. Spinal cord injury without radiographic abnormalities in children. Neurosurg. 1982; 57 (1): 114-129. doi: 10.3171/jns.1982.57.1.0114

22. Zou Z, Teng A, Huang L [et al.]. Pediatric Spinal Cord Injury without Radiographic Abnormality: the Beijing Experience. Spine. 2021; 46 (20): 1083-1088. doi: 10.1097/BRS.0000000000004030

23. Ren J, Zeng G, Ma Y.J.[et al.] Pediatric thoracic SCIWORA after during dance practice: a retrospective case series and analysis of trauma mechanisms. Childs Nerv Syst. 2017; 33 (7): 1191-1198. doi: 10.1007/s00381-017-3407-0

24. Booker J, Hall S, Dando A [et al.] Pediatric spinal trauma presenting to a UK major trauma centre. Child Nerv Syst. 2021; 37 (6): 1949-1956. doi: 10.1007/s00381-021-05044-8

25. Physical therapy treatment of a pediatric patient with symptoms consistent with a spinal cord injury without radiographic abnormality: A retrospective case report. / R. Butts, O. Legaspi, A. Nocera-Mekel [et al.]. J Bodyw Mov Ther. 2021: 27455-463. doi: 10.1016/j.jbmt.2021.01.008

26. Atesok K, Tanaka N, O'Brien A [et al.]. Posttraumatic Spinal Cord Injury without Radiographic Abnormality. Adv Orthop. 2018; 7060654. doi: 10.1155/2018/7060654
27. Liang Q.C., Yang B., Song B. [et al.]. Real spinal cord injury without radiologic abnormality in pediatric patient with tight filum terminale following minor trauma: a case report. BMC Pediatr. 2019; 19 (1): 513. doi: 10.1186/s12887-019-1894-8
28. Yang B., Song Y.H., Gao P.P. [et al.]. Real spinal cord injury without abnormality in pediatric patient with tight filum terminale following minor trauma: a case report. BMC Pediatr. 2019; 19 (1): 513. doi: 10.1186/s12887-019-1894-8
29. Boese C.K., Oppermann J., Eysel J. [et al.]. Spinal cord injury radiologic abnormality in children: a systematic review and meta-analysis. J Trauma Acute Care Surg. 2015; 78 (4): 874-882. doi: 10.1097/TA.0000000000000579
30. Rozzelle C.J., Aarabi B., Dhall S.S. [et al.]. Spinal Cord Injury Without Radiographic Abnormality (SCIWORA). Neurosurg. 2013; 72 (3): 227–233. doi: 10.1227/NEU.0b013e318277
31. Carroll T., Smith C.D., Liu X [et al.]. Spinal cord injures without radiologic abnormality in children: a systematic review. Spinal Cord. 2015; 53: 842-848. doi: 10.1038/sc.2015.110
32. Hon K.E, Chan S.J., Ng B.K. [et al.]. Spinal cord injury without radiographic abnormality (SCIWORA): A mere 50-cm fall that matters. Injury Extra. 2006; 37 (10): 364–370. doi:10.1016/j.injury.2006.03.021
33. Boese K, Muller D, Broer R [et al.]. Spinal cord injury without radiographic abnormality (SCIWORA) in adults: MRI type predicts early neurologic outcome. Spinal Cord. 2016; 54 (10): 878-883. doi: 10.1038/sc.2016.13
34. Alas H, Pierce K.E., Brown A. [et al.]. Sports-related Cervical Spine Fracture and Spinal Cord Injury: A Review of Nationwide Pediatric Trends. Spine. 2021; 46 (1): 22-28. doi: 10.1097/BRS.0000000000003718
35. Yalcin N, Dede O, Alanay A [et al.]. J Child Orthop.Surgical management of post-SCIWORA spinal deformities in children. 2011; 5 (1): 27–33. doi 10.1007/s11832-010-0306-2
36. Qi C, Xia H, Miao D [et al.]. The influence of timing of surgery in the outcome of spinal cord injury wirhout radiographic abnormality (SCIWORA). J Orthop Surg Res. 2020; 15 (1): 223. doi: 10.1186/s13018-020-01743-1
37. Iaconis Campbell J, Coppola F, Volpe E [et al.]. Thoracic spinal cord injury without radiologic abnormality in a pediatric patient case report. J Surg Case Rep. 2018; 2018 (1): 250. doi: 10.1093/jscr/rjy250
38. Kim S.K., Chang D.G., Park J.B. [et al.]. Traumatic atlanto-axial rotator subluxation and dens fracture with subaxial SCIWORA of Brown-Sequard syndrome: A case report. Medicine (Baltimore). 2021; 100 (16): 25588. doi: 10.1097/MD.0000000000025588
39. Chou J.U., Hoffman H.J., Hendrick E.B. [et al.]. Traumatic infarction of the spinal cord in children. J. Neurosurg. 1986; 65: 608-610. doi: 10.3171/jns.1986.65.5.0608
40. C. Kim, M. Vassilyadis, J.K. Forbes [et al.]. Traumatic spinal injuries in children at a single level 1 pediatric trauma centre: report of a 23-year experience. Can J Surg. 2016; 59 (3): 205-212. doi: 10.1503/cjs.014515
41. Dreizen D., Kim W., Kim J.S. [et al.]. Will the Real SCIWORA Please Stand Up? Exploring Clinicoradiologic Mismatch in Closed Spinal Cord Injuries. AJR Am J Roentgenol. 2015; 205 (4): 853-860. doi: 10.2214/AJR.14.13374
42. K. Yucesoy, K.Z. Yuksel SCIWORA in MRI era. Clinical Neurol and Neurosurg. 2008; 110: 429-433. doi: 10.1016/j.clineuro.2008.02.004

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MACRO- AND MICROMORPHOLOGICAL CHARACTERISTICS OF PLACENTA IN PHYSIOLOGICAL PREGNANCY AND COVID-19 AT DIFFERENT STAGES OF PREGNANCY

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Our article presents the macro- and micromorphological characteristics of placenta during physiological pregnancy and COVID-19 according to domestic and foreign literature. A search was made for foreign and domestic scientific publications on the morphological assessment of the placentas of healthy pregnant women and women with a confirmed diagnosis of COVID-19 (positive PCR test for SARS-CoV-2 virus).

In connection to the pandemic caused by a novel coronavirus infection, the study of the pregnancy and search for specific changes in women with a confirmed diagnosis of COVID-19 is of great interest among scientists around the world. Recent scientific publications focused mostly on nonspecific changes and signs of maternal and fetal vascular malperfusion. We reviewed publications, scientific articles, dissertations, literary reviews on E-library, Pubmed, Cyberleninka with access to the full text, whereas publications with paid access or abstract only were omitted.

Keywords: COVID-19, SARS-Cov-2, macroscopic changes, microscopic changes, placenta, umbilical cord, macrometry, morphological changes.

Despite the fact that pregnancy is a physiological process, its result is an adaptive mechanism [1]. Herewith changes in a woman's body should be maintained within the framework of average homeostasis and functional indicators, so-called "pregnancy norm" [6]. At the same time, during adaptive mechanisms, the body undergoes functional changes, taking into account hereditary, climatic-geographical, constitutional, age-related and other factors, which undoubtedly affect the course of pregnancy [8]. In the study of adaptive mechanisms, functional and morphological indicators, the placenta is a frequent object of research by anatomists, histologists, physiologists, and pathologists [3, 9]. The "mother-placenta-fetus" system during physiological pregnancy is in complex functional harmony. The placenta is an intermediate barrier organ (hemato-placental barrier) that develops during pregnancy, promotes the growth and development of fetus, structurally and functionally connecting the mother and fetus. Therefore, the placenta is an accurate record of the child's prenatal experience [5]. And without a doubt, the actualization of modern morphometric data on the placenta, on individual variability, age, ethnic characteristics and variability, taking into account the influence of external factors, is necessary in modern medicine. These data can be valuable scientifically and practically for establishing the norm of indicators and provide a personalized approach.

According to modern morphometric general data, placenta has a disk-like

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