Pediatric traumatic spinal cord injury

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Pediatric traumatic spinal cord injury (SCI) refers to damage to the spinal cord in children and adolescents due to external trauma. It is a complex and often devastating condition that can have long-term consequences for a child's physical, sensory, and neurological function.

Causes: Pediatric SCIs can result from various traumatic events, including motor vehicle accidents, falls, sports injuries, acts of violence, and recreational accidents. The causes may differ depending on the child's age and activities.

Types of Injuries: SCIs in children can be classified into complete and incomplete injuries. In a complete injury, there is a total loss of sensory and motor function below the level of the injury, while in an incomplete injury, some level of function is retained below the injury site.

Presentation: The symptoms of pediatric SCIs depend on the location and severity of the injury. Common symptoms may include loss of sensation, muscle weakness, paralysis, difficulty breathing, bowel and bladder dysfunction, and changes in blood pressure and heart rate.

Diagnosis: Pediatric SCIs are diagnosed through clinical assessment, neurological examination, and imaging studies such as X-rays, CT scans, and MRI. These tests help determine the location and extent of the injury.

Treatment: Treatment for pediatric SCIs may involve various medical and surgical interventions, depending on the specific injury. These treatments may include immobilization with braces or casts, surgery to stabilize the spine, and rehabilitation to promote recovery and regain function.

Prognosis: The prognosis for children with traumatic SCIs varies widely based on the severity of the injury and the level of the spine affected. Some children may experience significant recovery of function with rehabilitation, while others may have permanent disabilities.

Long-Term Care: Children with SCIs often require extensive long-term care, including physical and occupational therapy, assistive devices (e.g., wheelchairs), and psychological support to help them and their families adapt to the challenges of living with a spinal cord injury.

Preventative Measures: Preventing pediatric SCIs is crucial. This involves safety measures such as using child safety seats in vehicles, practicing sports safety, implementing fall prevention strategies, and educating children about the risks of activities that could lead to SCI.

Research and Advancements: Ongoing research and advancements in medical technology and rehabilitation techniques continue to improve the quality of life for children with SCIs. Innovations in regenerative medicine and neural prosthetics hold promise for potential future treatments.

Pediatric traumatic spinal cord injuries are a serious medical condition that requires a multidisciplinary approach involving physicians, surgeons, physical and occupational therapists, psychologists, and other specialists. Timely and comprehensive care can make a significant difference in the child's long-term outcome and quality of life.

Epidemiology

In developed countries, the proportion of TSCIs occurring in patients aged 0-15 years was 3% (95% CI: 2.2%; 3.9%), while in developing countries, it was 4.5% (95% CI: 2.8%; 6.4%). In developed countries, the pooled incidence of pediatric TSCI was 4.3/millions of children aged 0-15/year (95% CI: 3.1; 6.0/millions children aged 0-15/year) and boys comprised 67% (95% CI: 63%; 70%) of cases. The most prevalent level of injury was cervical (50% [95% CI: 41%; 58%]). The frequency of SCI Without Obvious Radiological Abnormality (SCIWORA) was 35% (95% CI: 18%; 54%) among children 0-17 years. The most common etiology in developed countries was transport injuries (50% [95% CI: 42%; 57%]), while in developing countries falls were the leading cause (31% [95% CI: 20%; 42%]). The most important limitation of the study was the heterogeneity of studies in reporting age subgroups that hindered us from age-specific analyses. The study provided accurate estimates for the epidemiology of pediatric TSCI. They observed a higher proportion of pediatric TSCI cases in developing country compared to developed country. Furthermore, we identified distinct epidemiological characteristics of pediatric TSCI when compared to adult cases and variations between developing and developed countries. Recognizing these unique features allows for the implementation of cost-effective preventive strategies aimed at reducing the incidence and burden of TSCI in children. What is Known: • Pediatric Traumatic Spinal Cord Injury (TSCI) can have profound physical and social consequences for affected children, their families, and society as a whole. • Epidemiological insights are vital for they provide the data and understanding needed to the identification of vulnerable populations, aiding in the development of targeted prevention strategies and effective resource allocation. What is New: • The estimated incidence of pediatric TSCI in developed countries is 4.3 cases per million children aged 0-15. The proportion of pediatric TSCI cases in relation to all-age TSCI cases is 3% in developed countries and 4.5% in developing countries. • The etiology of TSCI in pediatric cases differs between developing and developed countries. In developed countries, transport injuries are the most prevalent cause of pediatric TSCI, while falls are the least common cause. Conversely, in developing countries, falls are the leading cause of pediatric TSCI [1)]

This study sheds light on the epidemiology of pediatric TSCIs, highlighting differences between developed and developing countries. However, it is important to consider the limitations and the need for further research that delves into the specifics of age subgroups, causal factors, and the broader context of these injuries. Such insights can inform more effective prevention and intervention strategies and better address the needs of affected children and their families.

Reviews

Cunha et al. discuss the etiology and epidemiology of SCIs in children, highlighting the diverse range of causes. We explore the unique anatomical and physiological characteristics of the developing spinal cord that contribute to the specific challenges faced by pediatric patients. Next, we delve into the clinical presentation and diagnostic methods, emphasizing the importance of prompt and accurate diagnosis to facilitate appropriate interventions. Furthermore, we approach the multidisciplinary management of pediatric SCIs, encompassing acute medical care, surgical interventions, and ongoing supportive therapies. Finally, we explore emerging research as well as innovative therapies in the field, and we emphasize the need for continued advancements in understanding and treating SCIs in children to improve their functional independence and overall quality of life [2)]

Case series

Thirty cervical pediatric traumatic spinal cord injury patients (7.83 ± 1.206 years) and 30 age-, gender-matched healthy children as controls (HCs) (8.77 ± 2.079 years).

Field strength/sequence: 3 Tesla/Resting-state functional magnetic resonance imaging (rs-fMRI) using echo planar imaging (EPI) sequence.

Assessment: Amplitude of low-frequency fluctuation (ALFF), fractional ALFF (fALFF), and regional homogeneity (ReHo) were used to characterize regional neural function.

Statistical tests: Two-sample t-tests were used to compare the ALFF, fALFF, ReHo values of the brain between pediatric CSCI and HCs (voxel-level FWE correction, $P < 0.05$). Spearman correlation analyses were performed to analyze the associations between the ALFF, fALFF, ReHo values in altered regions and the injury duration, sensory motor scores of pediatric CSCI patients ($P < 0.05$). Then receiver operating characteristic (ROC) analysis was conducted to identify possible sensitive imaging indicators for clinical therapy.

Compared with HCs, pediatric CSCI showed significantly decreased ALFF in the right postcentral gyrus (S1), orbitofrontal cortex, and left superior temporal gyrus (STG), increased ALFF in bilateral caudate nucleus, thalamus, middle cingulate gyrus, and cerebellar lobules IV-VI, and increased ReHo in left cerebellum Crus II and Brodmann area 21. The ALFF value in the right S1 negatively correlated with the pinprick and light touch sensory scores of pediatric CSCI. When the left STG was used as an imaging biomarker for pediatric CSCI, it achieved the highest area under the curve of 0.989.

These findings may provide potential neural mechanisms for sensory motor and cognitive-emotional deficits in children after CSCI.

Evidence level: 2 TECHNICAL EFFICACY: Stage 5 [3)]

A retrospective analysis of hospital discharges among children aged 0-18 years occurring between 2016-2018 from U.S. hospitals participating in the Kids' Inpatient Database. ICD-10 codes were used to identify cases of SCI, which were then categorized by the presence or absence of comorbid TBI.

38.8% of children hospitalized with SCI had a co-occurring TBI. While DD disproportionately occurred among male children (67% of cases), when compared with children with isolated SCI, those with DD were not significantly more likely to be male. They were more likely to be Caucasian. The mean age of children with DD (13.2 ± 5.6 years) was significantly less than that of children with isolated SCI (14.4 ± 4.3 years). DD was associated with longer average lengths of stay (6 versus 4 days) and increased mean total hospital charges ($124,198 versus $98,089) when compared to isolated SCI.

Comorbid TBI is prevalent among U.S. children hospitalized with SCI. Future research is needed to better delineate the impact of DD on mortality, quality of life, and functional outcomes [4]

1)
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