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Prevalence and Prognosis of Spinal Injuries in Pediatrics versus Adults

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ABSTRACT

Background: Spinal cord injury (SCI) is a devastating neurological lesion, which has been demonstrated to be accompanied by considerable morbimortality. SCI, which happens in children and teenagers who remain developing represents a major challenge compared to SCI in adult population.

Objective: The aim of the current work was to compare between the prevalence and prognosis of spinal injuries in pediatrics versus adults.

Patients and Methods: This was a prospective study conducted on 80 SCI cases coming to Emergency Hospital, Mansoura University over a period of one year. They were divided into two groups: Group I included 40 SCI cases aged less than 18 years old and group II included 40 SCI cases aged more than 18 years old.

Results: Most of the studied pediatric cases were living in urban areas, while only 37.5% of which was living in rural areas. Regarding adults about 50% and 50% of the studied cases were < 40 and ≥ 40 respectively. Severe urinary tract infection (UTI) was significantly increased among adult ones compared to pediatric group, while bowel incontinence was significantly increased among pediatrics compared to adult group. No significant differences were determined between both groups as regards pressure ulcers, autonomic dysreflexia, respiratory complications and mortality within one week. Tetraplegia incomplete was significantly increased among pediatrics, while Paraplegia complete was significantly increased among adults.

Conclusion: SCI prevalence was demonstrated to be significantly correlated with urban residence in both pediatric and adults. Incomplete tetraplegia was significantly increased among pediatrics, while complete paraplegia was significantly increased among adults.

Keywords: Traumatic spinal cord injury, Tetraplegia, Paraplegia, Bowel incontinence.

INTRODUCTION

Trauma (T) is still a main cause of morbimortality all over the world, and most early preventable deaths owing to severe haemorrhage, in spite of recent advances in trauma care [1]. TSCI might be accompanied by various grades of paralysis, loss of sensation and urinary dysfunction. Of note, TSCI affects the health and is responsible a major economic burden on the families and societies [2]. The World Health Organization (WHO) recorded in 2009 in terms of SCI, the percentage of male to female (M/F) ratio in Egypt based on the ministry of health records was 71.1/28.9. The record displayed that the main etiologies of injury was motor vehicle collision (MVC) and the greatest distribution happened within the age from 20 to 30 [3].

Also, TSCI which happens in pediatrics and teenagers who remain developing represents a major challenge compared to SCI in adult subjects. On the other hand, data as regards the epidemiology of SCI in a population-based cohort is missing. As children and teenagers remains developing, TSCI which happens in the pediatrics represents various challenges compared to SCI in the adults. Although cause of injury is demonstrated to vary between pediatric and adult populations, data on the incidence and trend of pediatric SCI is missing, as the majority of researches focus mainly on adults. Understanding the epidemiology of pediatric SCI is of great importance to plan the allocations of resources and to develop prevention strategies [4].

The incidence rate represents the frequency of a novel disease in certain populations throughout a certain period. It has been demonstrated that SCI incidence increased progressively (except for usual daily activities). In the context of developed nation, the incidence differed from 13 to 163 out of million subjects [5]. The rates of non-developed nations differed from 13 to 220 per million subjects [6].

With regard to Egypt at Al-Quseir City, the prevalence rate of SCI was 63/100000 for the overall population. TSCI had a prevalence of 18/100000, on the other hand non-TSCI was demonstrated in 45/100000. Degenerative disc prolapse was the commonest cause of Spinal cord disease (SCD) with a prevalence rate of 27/100000 [7].

This study was done to compare between the prevalence and prognosis of spinal injuries in pediatrics versus adults.

PATIENTS AND METHODS

This was a prospective study carried out on SCI cases coming to Emergency Hospital, Mansoura University within the period from January 2021 to September 2021. Entire cases were divided into two groups: Group I comprised SCI cases with age less than 18 years old and group II included SCI cases with age more than 18 years old but less than 70 years.

METHODS

All cases were subjected to primary survey and resuscitation that included airway maintenance &

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cervical spine immobilization (head tilt, chin lift and Jaw thrust in cases with cervical injury), breathing and ventilation (endotracheal intubation if needed and mechanical ventilation), circulation and management of haemorrhage (intravenous fluids and vasopressors), disability (coma was managed by coma cocktail [Dextrose, thiamine and naloxone], convulsions was managed by antiepileptic measures [Intravenous benzodiazepine]), and segmental exposure.

Full history that included age, sex, residency, occupation, smoking habit, past history of previous surgeries and past history of medical diseases. Complete clinical examination included physical examination [heart rate, blood pressure (BP), temperature and respiratory rate (RR)], abdominal examination, chest examination and cardiac examination.

Laboratory investigations comprised CBC, liver function tests (LFTs), kidney function tests (KFT), and INR. Radiological examinations included focused assessment with sonography (FAST), X-rays and computerized tomography (CT) Brain if needed.

Level of injury was categorized as tetraplegia, paraplegia, and unspecified based on the ICD 9-SCI. An approximation of the AIS is based on the 5th digit of ICD-9-CM diagnosis codes [8]. Subjects were classified as complete tetraplegia, incomplete tetraplegia, complete paraplegia, incomplete paraplegia and unspecified. Etiology was grouped as MVC, violence, sport injuries, and falling. Different causes were classified together. Length of hospital stay (LOS) was evaluated in all admitted cases also from the onset of admission till being discharged.

Outcomes

The outcomes were assessed according to ward admission, ICU admission, mechanical ventilation, length of hospital stay (LOS), mortality within one week and surgical interference.

Ethical Considerations: Study protocol was submitted for approval by Mansoura Faculty of Medicine Ethical committee, which gave its approval to this study. Approval of the mangers of the healthcare facilities where the study was conducted. Informed written consents were obtained from all studied participants. Confidentiality was respected. Collected data not to be utilized for any other purpose. The Helsinki Declaration was followed throughout the study's conduct.

Statistical Analysis

Data analysis was carried out by SPSS software, version 25 (SPSS Inc., version 25, Chicago). Qualitative data were defined by utilizing number and percent. Quantitative data were described by utilizing mean ± SD for normal distribution of data following evaluating normal distribution by utilizing Kolmogorov-Smirnov test. Chi-Square and Fisher exact tests were utilized for comparison of qualitative data between groups. Student t-test was utilized to compare two independent groups for normal distribution of data. The results were considered significant when $P \leq 0.05$.

RESULTS

This study comprised 80 cases divided into two group: Group I comprised 40 SCI cases with age less than 18 years old and group II included 40 SCI cases with age more than 18 years old. Table (1) demonstrated demographic characteristics of the studied pediatric cases. About 55% and 45% of the studied cases were < 10 and ≥10 respectively. Male to females (M/F) ratio was 80/20. Most of the studied cases were living in urban areas, while only 37.5% of them were living in rural areas.

Table (1): Demographic data of the studied pediatric patients

	n=40	%
Age (years)		
<10	22	55.0
≥10	18	45.0
Sex		
Male	32	80.0
Female	8	20.0
Residence		
Urban	24	62.5
Rural	16	37.5

Table (2) revealed demographic characteristics of the studied adult cases. About 50% and 50% of the studied cases were < 40 and ≥ 40 years respectively. Male to females (M/F) ratio was 67.5/32.5. Most of the studied cases were living in urban areas, while only 37.5% of which were living in rural areas. As regards occupation, most of the studied cases were manual workers (62.5%), followed by employee (27.5%) and lastly housewives (10%). In addition, 55% of the studied cases were smokers.

Table (2): Demographic data of the studied adult cases

	n=40	%
Age /years		
<40	20	50.0
≥40	20	50.0
Sex		
Male	27	67.5
Female	13	32.5
Residence		
Urban	25	62.5
Rural	15	37.5
Occupation		
Manual worker	25	62.5
Employee	11	27.5
Housewife	4	10.0
Smoking history		
-ve	18	45.0
+ve	22	55.0

Table **(3)** demonstrated comparison of mode of trauma, past history of previous surgeries and past medical surgical history between pediatric & adult cases. There were statistically significant differences between both groups as regards mode of trauma (MVC significantly increased among pediatrics, while work related injuries were significantly among adults), past history of previous surgeries (being significantly increased among adults) and past medical history (being significantly increased among adults) (P<0.05). There were no statistically significant differences between both groups as regards LOS, mechanical ventilation and ICU admission (P > 0.05).

Table (3): Comparison of mode of trauma, past history of previous surgeries, past medical surgical history, length of hospital stay, mechanical ventilation and ICU admission between pediatric and adult cases

	Pediatric n=40(%)	**Adult n=40(%)**	**Test of significance**
Mode of trauma Motor vehicle Sport injury Work related injuries Others	 36(90) 1(2.5) 0 3(7.5)	 26(65) 2(5) 8(20) 4(10)	 MC=10.09 **p=0.018***
Past history of previous surgeries	2(5)	8(20)	X^2=4.11 **p=0.043***
Past medical history -ve +ve	 34(85) 6(15)	 13(32.5) 27(67.5)	 X^2=22.74 **p<0.001***
Length of hospital stay (days)	14.98±4.68	14.58±4.91	t=0.373 p=0.711
Mechanical ventilation	25(62.5)	18(45)	X^2=2.46 p=0.116
ICU admission	36(90)	39(97.5)	X^2=1.92 p=0.166

MC: Monte Carlo test, X^2= Chi-Square t test, t: Student t test, *statistically significant

Tetraplegia incomplete was significantly increased among pediatrics, while paraplegia complete was significantly increased among adults. No significant differences was recorded between both groups as regards tetraplegia complete, tetraplegia incomplete and unspecified (Table 4).

Table (4): Comparison of level of injury between adult and pediatric cases with spinal cord injury

Level of Injury	**Pediatric n=40(%)**	**Adult n=40(%)**	**Test of significance**
Tetraplegia complete	13 (32.5)	12 (30)	X^2=0.058 p=0.809
Tetraplegia incomplete	20 (50)	0	X^2=26.6 **p<0.001***
Paraplegia complete	0	26 (65)	X^2=38.52 **p<0.001***
Tetraplegia incomplete	5(12.5)	2(5)	X^2=1.41 p=0.235
Unspecified	2(5)	0	FET=2.05 p=0.15
Cervical **Lumbar**	25 (62.5) 15 (37.5)	10 (25.0) 30 (75.0)	X^2=11.43 **p=0.001***

X^2= Chi-Square t test, FET: Fisher exact test, *statistically significant

Severe UTI was significantly increased among adult ones compared to pediatric group (P < 0.05), while bowel incontinence was significantly increased among pediatrics compared to adult group (P < 0.05). No significant differences were recorded as regards all the remaining complications (Pressure ulcers, autonomic dysreflexia, respiratory complications and mortality within one week) (P > 0.05).

Table (5): Comparison of complications frequency between adult and pediatric cases with spinal cord injury

	Pediatric n(%)	**Adult n(%)**	**Test of significance**
Severe UTI	21(52.5)	31(77.5)	X^2=5.49 **P=0.019***
Bowel incontinence	33(82.5)	12(30.0)	X^2=22.40 **P=0.0001***
Pressure ulcers	18(45)	24(60)	X^2=1.81 P=0.179
Autonomic dysreflexia	18(45.0)	13(32.5)	X^2=1.32 P=0.359
Respiratory complications	12(30)	9(22.5)	X^2=0.581 P=0.446
Mortality within one week	3(7.5)	4(10.0)	FET=0.157 P=1.0

X^2= Chi-Square t test, FET: Fisher exact test, *statistically significant.

DISCUSSION

SCI is a devastating neurologic lesion, which has been demonstrated to be accompanied by considerable morbimortality. Pediatric SCI represents about five percent of all SCI. Recognition of changes in anatomical and epidemiological features between children and adults SCI is paramount to the precise assessment, management of this potentially debilitating pathology. Notably, medical optimisation and decompression, stabilisation, and/or fusion in certain patient groups involve the establishment of high-quality SCI care [9].

Of note, there are several research that discussed the prevalence and outcomes of SCI among pediatrics and adults individually. However, there are limited number of research that compared between adults and pediatrics in the context of SCI. Thus, the aim of the current work was to compare between the prevalence and prognosis of spinal injuries in pediatrics versus adults.

Regarding demographic characteristics of the studied pediatric cases, the current study revealed that M/F ratio was 32 males, 8 females (80/20%). Most of the studied cases were living in urban areas, while only 37.5% of which was living in rural areas. The majority of children with SCI in the cervical region are mainly owing to blunt traumas [10]. In the context of SCI, a lot of studies have demonstrated that the M/F ratio was from 1.5:1 to 1.9:1 [11, 12].

In addition, MVC, that represent about 50% of whole injuries, are the commonest mechanism of injury in pediatrics [10, 12]. The mean percentages of occupants was 36.5% prevail over those to pedestrians (13.5%) and bicycle riders (5.5%) [10-12]. Falling represent 18% to 30% of cervical spine injuries (CSI) in cases with younger age (less than eight years) and eleven percent in cases with older age (more than eight years). Sport injuries are very common among older cases (29%) and rare in the younger cases (three percent) [10, 12]. In addition, non-accidental traumas and penetrating injuries are demonstrated in minor numbers of young children and teenagers, correspondingly [11, 13].

The largest recorded series of pediatric CSI cases was gleaned from a ten-year interval of the NPTR and may represents the best epidemiologic data from such populations. In addition, 83% of such cases had bony CSI. Fractures were very common in all ages, even though dislocations were very common among younger cases compared to older ones in the context of pediatric populations. Upper CSI were almost two-fold as common as lower CSI. Moreover, 7% of the cases had an upper and lower CSI. SCI happened in 35% of the pediatric CSI. Approximately 1/2 of these displayed no radiological evidences of bony injuries. Furthermore, 75% of SCI were partial and 25% were complete [10]. Pediatric SCI is a fatal emergency condition, which has been displayed to be associated with critical outcomes and high morbimortality in pediatrics if not treated in a prompt manner. Generally, in the previous years, there is a gradual increase in SCI frequencies all over the world and differed from thirteen per million to 163 per million subjects based on the expansions of activities among various geographical areas [5, 14]. With regard to pediatrics, TSCI was comparatively uncommon, representing about 3.5% of SCI [13]. In terms of younger adults, more than eighty percent of DCI happen in the cervical region. On the other hand, the mean percentage of CSI among adults is about 35% [15]. In addition, it was measured that thoracolumbar spine injuries account for 7.5% of all pediatric spinal traumas. Beyond the age of 14, it has been demonstrated that CSI ratio reduced and become within the average of the adult pattern [16]. Such epidemiological characteristics could be clarified by the interference of a lot of factors which include large-sized head and soft elastic tissues, as well as horizontal facet alignment [17]. In addition, mortality rate in CSI among pediatrics was recorded to be about 17%, with greater rate in upper cervical injured cases [18].

Most of the studied cases were living in urban areas, while only 37.5% were living in rural areas. With regard to occupation, most of the studied cases were manual workers (62.5%), followed by employee (27.5%) and lastly housewives (10%). In addition, 55% of the studied cases were smokers. **Taşoğlu *et al.*** [19] have demonstrated in their study that among 262 persons with SCI, 69.8% were males. The average age was 38 years. Falls were the commonest etiology of injuries. Most of falls were falls from a height (FFH) (93.3%). More than 20% of FFH were associated with occupational injuries. The commonest neurologic injury was at the first lumber level (L1).

The percentages of thoracic, lumber, and cervical cord affections were 46.2%, 27.5% and 26.3% respectively. The average rehabilitation period was 52.1 ± 25.5 days. Of note, subjects with motor complete injuries and with a shorter time since injury had longer period of rehabilitation compared to motor complete injuries free ones. **Yang *et al.*** [20] have displayed that the ratio of cases with SCI increased to 14%. The M/F ratio was 3:1. The main etiology of SCI was MVC (21.7%). A lot of the injured cases were workers (36.2%), peasants (22.8%), and unemployed subjects (13.9%) such occupations represented about 72.9%. In addition, they have demonstrated that the OR for male gender in comparison with female gender was 1.25, the OR for having a spinal fractures was 1.56, the OR for having a thoracic injuries was 1.23, and the OR for having adverse events was 2.47.

In terms of etiology, **Barbiellini and Amidei** [21] have demonstrated that most traffic SCIs were CSI (52.1%), and the commonest etiology of injuries were MVC (29.9%) followed by occupational accidents (29.8%). Of note, in all developed nations the general incidence of SCI is roughly 11.5 to 53.4 per million every year [22]. Notably, deaths before admission aren't counted in an appropriate manner. There is difference in SCI prevalence and cause across ethnicity, sex, and age. SCI is very common among non-Hispanic blacks who represent about 24% of SCIs in the United States, in

spite of only including 13% of the subjects [23, 24]. Although males are in a disproportionate manner afflicted with SCIs in the adolescence and adults, they comprised about 78% of all SCIs [23]. By comparison between adult versus children, **Hagan *et al.*** [9] have demonstrated that males comprise most SCIs as regards adults, while, for children less than ten years old, no sex differences were recorded (affected by the same degree). In addition, adult SCI most frequently from MVC, sport injuries, work-related accidents, while children most frequently from falling and MVC. In addition, **DeVivo and Vogel** [25] have demonstrated that males were associated with a consistent reduction in the ratio of novel cases of SCI, ranging from 83% (in cases with age from 16 to 21) to 51% (in cases with age from zero to 5 years). Among children and adolescents (< 22 years old), the ratio of SCI owing to MVC was greater than in adults (beyond the age of 22). Sports, violence, and iatrogenic adverse events represent a significantly higher ratio of SCI in teenagers than in adults.

Parent *et al.* [26] have demonstrated that the epidemiologic characteristics of pediatric SCI demonstrate that such injuries are comparatively rare and that the mechanism of injury is different based on the age at time of injury and in comparison with the adult population.

With regard to complications, the preset study demonstrated that severe UTI was significantly increased among adult ones compared to pediatric group (P<0.05), while Bowel incontinence was significantly increased among pediatrics compared to adult group (P<0.05). No significant differences were recorded as regards all the remaining complications (Pressure ulcers, Autonomic dysreflexia, Respiratory complications and Mortality within one week) (P>0.05). Also, **Yang *et al.*** [20] have displayed that 12.8% of the SCI cases acquired adverse events. The four primary adverse events were respiratory infections (37.6%), urinary tract infections (26.3%), bed sores (13.6%), and electrolyte imbalance (10.3%). The percentages of cases with complete SCIs acquiring respiratory infections, UTI, bed sores, and electrolyte imbalance were 51.4%, 38.0%, 32.8%, and 25.5%, respectively.

In terms of level of injury, the current study demonstrated that tetraplegia incomplete was significantly increased among pediatrics, while paraplegia complete was significantly increased among adults. No significant differences were recorded between both groups as regards tetraplegia complete, tetraplegia incomplete and unspecified. **Taşoğlu *et al.*** [19] revealed that the commonest NLI was L1, then T12, L2 and then C4 correspondingly. L1 was the commonest level in males, on the other hand T12 was the commonest level among females. The distribution of SCI was similar for both genders. T12-L1-L2 levels have been demonstrated to be the most commonly affected areas followed by CSI. The percentages of thoracic, lumber and cervical injuries were 46.2%, 27.5% and 26.3% correspondingly. Tetraplegia complete and incomplete were recorded in 6.1% and 20.2% of cases respectively. Paraplegia complete and incomplete were recorded in 29% and 44.7% of cases correspondingly. Also, **Yang *et al.*** [20] have revealed that the greatest number of subjects sugaring a SCI complained a cervical injury (1720 cases) followed by thoracic and lumbar injuries (1264 and 941 cases, correspondingly). In the context of injury degree, there were more cases of incomplete injuries than complete injuries. This result demonstrated that the percentages of cervical, thoracic, and lumber injuries were 21.8%, 14.6%, and 15% correspondingly. The distribution of severity at the various spinal levels were all significant. Of note, the incidence of cervical, thoracolumbar or sacral injuries, differs a lot in preceding literature [27, 28]. Another Chinese study conducted by **Hagen *et al.*** [29] reported cervical lesions represent below < 5% of cases hospitalized with TSCI. On the other hand, another Turkey study revealed that the percentage rises to 92%. Such variability could be partially clarified by different etiologies, although the lack of proper management in terms of the geographical and financial levels determined, is likely to participate in a considerable underreporting in a lot of nations. Socioeconomic disparities may have a role in minor ratios of cases presenting with CSI given their greater possibility of death before reaching the hospital and being as a result recognized as incident TSCI cases.

With regard to recovery, our study revealed that there were no significant differences between both groups in terms of LOS, mechanical ventilation and ICU admission (P>0.05). It has been demonstrated that neurological recovery seems to have promising results compared to adults. Although major series of cases are rare and no comparative researches between adults and children have been conducted [30]. Pediatric patients with traumatic SCI have a better neurologic outcomes compared to adults. Cases with SCI before their adolescent growth spurt have a great possibility of scoliosis development. Owing to such changes, TSCI must be highly suspected in the existence of abnormal neck or neurologic examination, or a distracting injury, even in the lack of radiographic anomalies [26]. In the same line, **Ma *et al.*** [31] have demonstrated that irrespective of time since injury, subjects sustaining a pediatric SCI recorded better health compared to the adults subjects. The outcomes highlight the significance of a detailed life-course approach to SCI rehabilitation, regardless of age at the onset of injury.

CONCLUSION

Spinal cord injuries (SCI) prevalence was demonstrated to be significantly correlated with male sex and urban residence in both pediatric and adults. Also, manual working and smoking were significantly involved among adult ones only. Severe UTI was significantly increased among adult ones, while Bowel

incontinence was significantly increased among pediatrics. Both pediatrics and adults demonstrated comparable outcomes as regards LOS, mechanical ventilation and ICU admission. Tetraplegia incomplete was significantly increased among pediatrics, while paraplegia complete was significantly increased among adults.

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