Research Article

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Path to Prevention of Spinal Trauma in a Low- to Middle-income Country: A Single-center Study in Phnom Penh, Cambodia

Melvin C. Makhni, MD, MBA
Naazanene M. Vatan
Paul J. Park, MD
Zain A. Kabeer
Meghan Cerpa, MPH
Jee-Hye Choi
Joseph M. Lombardi, MD
Smey Hong
Yongjung Kim, MD
Lawrence G. Lenke, MD
Ronald Lehman, MD
Iv Vycheth, MD
Kee B. Park, MD

Abstract

This study sought to characterize the epidemiology and outcomes of spinal trauma, with or without a neurologic deficit, at a major government hospital in Phnom Penh, Cambodia. Patient demographics, American Spinal Injury Association (ASIA) score on presentation, location of injury, and cause of injury from 316 patients from September 2013 through December 2016 were compiled. Outcome measures included length of hospitalization and surgical intervention. Falls were the leading cause of spinal injury (50.6%), followed by motor vehicle accidents (29.3%) and other accidents (20.1%). Patients who fell from height had higher surgery rates (P = 0.014), and men had worse ASIA scores (P = 0.0013). Patients with ASIA A-C had a mean age of 38.17 years, whereas the D-E group was on average 42.88 years. Motor vehicle accidents caused the most cervical spine injuries, whereas falls caused more thoracic and lumbar trauma (P = 0.0005). Younger, working men are experiencing more severe spinal injuries, undergoing more surgery, and staying hospitalized longer than other demographics in Phnom Penh. This study characterizes spinal trauma from falls as a public health issue in Cambodia, highlighting the importance of fall injury prevention. Protecting this cohort is an important investment for Cambodia and necessitates workplace reform and safety standard implementation.

Correspondence to Vatan: mmakhni@bwh.harvard.edu

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Spinal trauma can be an emotionally and economically devastating injury for patients. In lower to middle income countries, where many patients' incomes come from farming and manual labor, spinal trauma can take a particularly overwhelming toll on patients and their families. This makes the well being of the male, working-age cohort, especially important to the overall future of these countries. Rehabilitation and treatment of spinal trauma is costly and requires dedicated follow-through; in regions lacking the healthcare infrastructure and facilities to support disabled patients, survival rates can be very poor.[1,2] Understanding

the contributing factors to spinal injuries in these countries is critical to decreasing their prevalence.

Traffic accidents are a well-established contributor to spinal trauma injuries and are recognized as a leading cause of morbidity and mortality in the lower to middle income country.[1,3-6] The World Health Organization predicts that by 2020, road traffic injuries will be the third leading contributor to global burden of disease and injury.[7] Overcoming high traffic accident rates starts with prevention, although it is a notable undertaking requiring not only trillions of dollars of infrastructure improvements but also cultural changes among all drivers,[1,8] which makes understanding other causes of spinal injury and trauma even more critical to address the issue from several angles. Our study sought to investigate what these other causes of spinal trauma may be and the rates of subsequent disability in these regions.

We had the unique opportunity to analyze spinal trauma data from Preah Kossamak Hospital over a period of 3 years, a major government hospital in Phnom Penh, the capital of Cambodia and its most populous city. By better understanding the epidemiology of spinal trauma in Cambodia, we hoped not only to illustrate the contribution of road traffic accidents to this debilitating injury but also to find additional, potentially preventable causes. Unlike previous studies completed in this area, our data were not limited to spinal cord injury (SCI) alone but rather spinal trauma with or without a neurologic deficit as well over a 3-year period, allowing for a more comprehensive and detailed overview.

Methods

This study was a cross-sectional study approved by the Cambodian National Ethics Committee for Health Research (Protocol no. 350 NECHR). From September 4, 2013, to December 9, 2016, a database was compiled of all radiographically confirmed spinal trauma admitted to the Department of Neurosurgery at Preah Kossamak Hospital. Any acute spinal injury patient presenting within 30 days of initial injury was charted and included in our study. All spinal injuries were included regardless of injury severity or energy of trauma. For each case, the patient's demographic data, spinal level of injury, cause of injury (COI), American Spinal Injury Association (ASIA) score on arrival, hospital length of stay (LOS), and clinical management were recorded. Patient data were collected on an on-going basis from paper records, in-hospital interviews with the patient and/or family members, and postdischarge phone calls. Postdischarge phone calls were made 1 to 6 months after the patient was released from the hospital. The collected information was stored in a secure and confidential manner on FileMaker Pro 12.0v5.

Once the data were collected, each case was reviewed and confirmed as an acute spinal trauma (injury within 30 days before initial presentation); chronic spinal injury patients were excluded. Patients without a documented diagnosis of spinal trauma, or those cases in which all the aforementioned variables were not readily available or clearly documented, were excluded. A total of 316 patients were ultimately included in our study.

Variables included in our analysis were age, sex, location of injury, COI, ASIA impairment scale at admission, surgical intervention, and LOS. COI was divided into the following three groups: motor vehicle accidents (MVAs), falls, and other accidents. Age and LOS were both treated as continuous variables. Patients' ASIA assessments were grouped into two categories of ASIA scores A-C and D-E, and ASIA group was analyzed as a categorical, binary variable. Surgical intervention was represented as a binary variable as well, indicating whether a patient underwent surgical intervention. The location of injury was divided into cervical, thoracic, or lumbosacral based on the patient's primary spinal level of injury.

For statistical calculations, a 2-sided chi-squared test was used for categorical variables. For continuous and categorical variable analysis, a 2-sided Student *t*-test was used. Significance was defined as $P \leq 0.05$.

Results

A total of 316 spinal trauma patients were included in our study. The average age overall was 40 years, and 74.7% were men (Table 1). The average age of male patients was 38 years, whereas female patients were on average 48 years ($P < 0.0001$) at the time of injury. The most common cause of spinal trauma injury was fall (50.6%), followed by MVAs (29.3%) and other accidents (20.1%). Spinal trauma patients were found to stay in the hospital for a mean of 14 days.

From the Columbia University (Vatan, P. J. Park, Kabeer, Cerpa, Lombardi, Kim, Lenke, and Lehman) and the Mount Sinai Health Systems (Choi), New York, NY; the Preah Kossamak Hospital (Hong and Vycheth), Phnom Penh, KH, Cambodia; the Harvard Medical School (K. B. Park and Makhni), Boston, MA; and the Brigham and Women's Hospital (Makhni), Boston, MA.
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Table 1

Summary of Demographic and Outcome Data Relative to COI

	Overall (n = 316)	MVA (n = 94)	*P* Value	Fall (n = 159)	*P* Value	Other (n = 63)	*P* Value
Demographic							
Age[b] (yr)	40.09 ± 15.6	37.82 ± 14.6		41.93 ± 15.9		38.84 ± 15.7	
Gender[a]							
Female	80 (25%)	23 (24%)	0.97	41 (26%)	0.97	16 (25%)	0.97
Male	236 (75%)	71 (76%)		118 (74%)		47 (75%)	
Location[a]							
Cervical	101 (32%)	43 (47%)		35 (22%)		23 (37%)	
Thoracic	74 (24%)	20 (22%)	0.0005	37 (23%)	0.0005	17 (27%)	0.0005
Lumbar	139 (44%)	29 (32%)		87 (55%)		23 (37%)	
ASIA[a]							
A-C	153 (51%)	43 (51%)	0.73	76 (50%)	0.73	34 (56%)	0.73
D-E	145 (49%)	41 (49%)		77 (50%)		27 (44%)	
Outcome							
Underwent surgery[a]	166 (53%)	51 (54%)	0.68	85 (53%)	0.68	30 (48%)	0.68
LOS[b] (d)	14.13 ± 9.2	15.38 ± 9.2		13.37 ± 8.9		14.15 ± 8.4	

ASIA = American Spinal Injury Association, COI = cause of injury, LOS = length of stay, MVA = motor vehicle accident
[a] Values listed represent n, followed by column percentage.
[b] Values represent mean ± one SD.

Among the 159 fall patients, 51 were specifically a fall from height (tree). Of these falls from height, 35 (69%) had injuries to their spine that required surgical intervention. Within the subgroup of 159 patients who had falls, those who fell from height were 2.5 times more likely to undergo surgery ($P = 0.009$). Relative to the overall cohort of 316 patients in this study, patients who fell from height still had a significantly higher rate of undergoing surgery ($P = 0.01$).

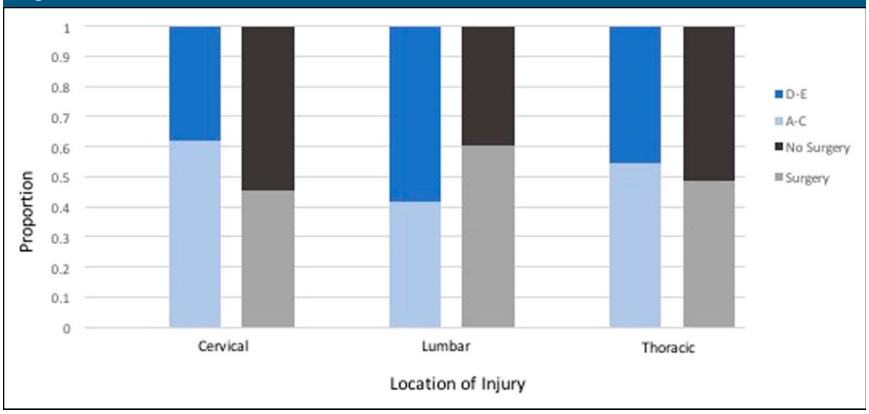
As expected, younger patient age was found to correlate with both higher severity ASIA group ($P = 0.008$) and subsequently the rate of surgery ($P < 0.0001$). Patients given ASIA scores of A-C had a mean age of 38 years, whereas patients given scores of D-E had a mean age of 43 years. Patients who underwent surgery were on average 37 years old, whereas patients with no surgery were on average 7 years older, at 44 years. Regression analysis indicated that age is also a significant variable when predicting LOS; younger patients had significantly longer hospitals stays ($P = 0.006$). Although age accounts for 2.6% ($r^2 = 0.026$) of the variability found in LOS, a complex multifactorial variable, it is important to note that the analysis identified younger patients are accounting for increased LOS rather than older patients. Patients in the A-C ASIA group had a mean LOS of 17 days, approximately 5 days longer than those in the D-E group ($P < 0.0001$). Similarly, patients who underwent surgery also had longer LOS, at 19 days, than patients who had no surgery and stayed in the hospital for an average of 9 days ($P < 0.0001$).

A significant relationship was also found between ASIA score and sex, as men tended to have worse ASIA scores ($P = 0.001$). Of the 153 patients in the ASIA A-C group, 127 patients were men, whereas of the 145 patients in the ASIA D-E group, only 67 patients were men.

ASIA group was correlated with injury location ($P = 0.009$). 62.2% of patients with cervical spine injuries received ASIA scores of A-C, 54.17% for thoracic injuries, and 41.8% for lumbar injuries (Figure 1). Similarly, injury location was also found to be correlated with the rate of surgery ($P = 0.05$). Interestingly, only 45.5% of cervical spine trauma patients and 48.6% of thoracic spine trauma patients had surgery, whereas 60.4% of lumbar spine trauma patients underwent surgery (Figure 1). Possible explanations include availability of resources to perform complex cervical spine surgery, or surgery may not have been indicated in more severe SCI patients given prognosis.

COI did not show a notable correlation with the ASIA score; 50% of falls and 51% of MVAs were ASIA A-C (Table 1). However, injury location was found to be correlated with COI ($P = 0.0005$). MVAs were found to cause the highest percentage of cervical spine injuries, whereas falls caused higher rates of lumbar and thoracic spine trauma (Table 1).

Figure 1



Relationship of injury location, ASIA impairment score, and surgical intervention. ASIA = American Spinal Injury Association

Discussion

Spinal trauma has a profound effect on patients in low- to middle-income countries. Often relying on manual labor to make a living, these injuries can be debilitating, especially when the healthcare infrastructure is not developed to handle the extensive surgical and rehabilitative care required for meaningful recovery. Our study looked specifically at a large hospital in the capital of Cambodia to better understand the causes behind these types of injuries. Although the role of road traffic injury has been well-defined in this area, our study looked for other preventable causes that may help guide prevention strategies and resource allocation.

We built off prior work from our group looking at pilot data about the epidemiology of spinal trauma in Cambodia's general hospital in Phnom Penh. However, this study evaluated 80 patients from 2013 to 2014, whereas our study encompassed 316 patients over more than 3 years. We focused specifically on patients who had acute trauma, selecting for those who had recent trauma and excluding those who had prior trauma and were transferred late to the hospital. Although they also showed falls to be the predominant COI followed by MVAs, we were able to do notable subgroup analysis on the patients regarding the groups within the variables studied such as age, ASIA status, and location of injury.[9] Previous reports on spinal trauma in Asian countries have been limited mainly to patients with severe SCI and/or head trauma,[2-5,10-13] as opposed to cervical, thoracic, or lumbar spine trauma with or without a neurologic deficit. Although these reports provide meaningful insight on SCI rates, they consider only a fraction of patients who endure spinal trauma. Spinal trauma patients who do not suffer from SCI often still endure severe financial and health-related consequences, such as costly surgery, extended hospitalizations, and lifelong disability.[1,4,5,8,14,15] An analysis of patients with varying degrees of spinal trauma allows for a more comprehensive evaluation of potential preventive measures.

Several studies have attempted to characterize regional rates of traumatic SCI (TSCI) in various cohorts. Kumar et al.[16] gave a recent estimate that the global incidence of TSCI was 10.5 cases per 100,000 persons. Jazayeri et al.[5] performed a meta-analysis of TSCI rates globally and found that the numbers varied greatly by country, ranging from 3.6 to 195.4 affected patients per million. The review also noted the availability of incident data across various countries and reported that low-income countries lack the epidemiological information in TSCI that most high-income, developed countries had. Most importantly, the study concluded that although rates of TSCI are decreasing in developed countries such as the United States, France, and Australia, incidence is increasing in lower to middle income countries. This comparison of trends suggests that lower to middle income countries can take measures to protect their populations from TSCI.

In addition to studies on the global scale, more regional studies have also been found again with a focus on SCI, rather than looking at spinal trauma overall. Ning et al performed a systematic review of TSCI rates throughout Asia. Ning et al[17] reported an incident age range of 26.8 to 56.6 years for TSCI, similar to the average age at the time of injury seen in our study. Men were also noted to have higher rates of injury. The largest contributor to TSCI injuries was found to be MVAs at 59.5%, followed by falls at 37.8%. Our study also found that men were three times as likely to suffer from spinal trauma as women; however, in Cambodia, we found that falls were the most common COI (50.64%), followed by MVAs (29.30%), then other accidents (20.06%). This discrepancy may be explained by a difference in patient demographics and whether the hospital served mainly urban or rural cohorts. Nevertheless, in both studies, road traffic injuries and falls were the two major causes of spinal trauma.

A retrospective analysis of SCI by Ibrahim et al[12] narrowed its focus to a single center, the Department of Rehabilitation Medicine at Hospital Kuala Lumpur in Malaysia. Ibrahim et al also found the average age of

SCI patients to be 39 years. Like the previous study, Ibrahim et al found that MVAs were the most common cause of TSCI injury at 66%, followed by falls at 28%. This discrepancy can once again be explained by referral bias, as the majority of the urban hospital's patients were from the immediate surrounding area. By taking data from a central government hospital that admit patients from both urban and rural settings, our study was able to evaluate a broader, more general cohort and found that falls are a larger contributor to spinal trauma than previously thought.

Our study had several limitations. First, our study was retrospective. Without an established electronic medical record, data collection relied on direct review of paper charts. Second, reliable follow-up was an inherent obstacle in the setting of a low-resource hospital. Despite this, our study was able to obtain a relatively large study cohort with complete data for each patient included from a thorough chart review and diligent follow-up.

Several key findings of this study are crucial for understanding and preventing future spinal trauma injuries in Cambodia. As expected, younger men suffer spinal trauma more frequently and often have more severe injuries requiring more surgery, which has large implications on a national level with regard to the working-age cohort. We also found that falls were the main cause of spinal trauma in our cohort, unlike the majority of previous data in this field. Understanding this difference is critical and warrants that additional attention not only on traffic safety but workplace safety as well. Similar to preventing road traffic injuries, several safety protocols could be implemented for falls, including education, safety practices, and guidelines, as well as tools such as harnesses and other safety equipment. By investing in fall prevention, the benefit to society would be substantial in protecting the working-age male cohort from disability—not only by increasing productive working years but also by obviating the notable financial burden these injuries often necessitate. As with any single-center institution, generalizability is an important factor in using these data: however, given the varied cohort seen at this one institution in Phnom Penh across both rural and urban cohorts, as well as our broader inclusion criteria for spinal trauma with or without a neurologic deficit, we believe this study highlights an additional injury cohort that can and should be addressed in the low- to middle-income country. By turning attention to preventing fall injuries with this study, we hope to provide a foundation for future studies to address how to alleviate this burden not only in Cambodia but also in other countries with similar risk factors.

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