Spine Trauma as a Component of Essential Neurosurgery: An Outcomes Analysis from Cambodia

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■ OBJECTIVE: **In recent years, delivery of cost-effective "essential neurosurgery" in resource-limited communities has been recognized as an indispensable part of health care and a global health priority. The aim of this study was to review outcomes from operative management of spine trauma at a resource-limited government hospital in Phnom Penh, Cambodia, and to provide an epidemiologic report to guide prevention programs.**

■ METHODS: **A retrospective review of a prospective neurosurgical database was performed to identify risk factors for spine trauma and severe spinal cord injury (American Spinal Injury Association A or American Spinal Injury Association B) and to evaluate the cost-effectiveness of surgery for patients treated at Preah Kossamak Hospital for subaxial and thoracolumbar spine trauma from 2013 to 2016.**

■ RESULTS: **Surgical treatment was provided to 277 patients with cervical or thoracolumbar spine trauma, including 36 facet dislocations and 135 thoracolumbar burst fractures at a cost of $100–$280 per surgery. Six patients (2.2%) required treatment for postoperative wound infection. Reoperation was performed in 8 patients (2.9%) for wrong-level surgery. Failure of short-segment pedicle screw fixation was discovered in 4 patients (7.0%). Neurologic improvement was reported by 64 patients (65.3%) with incomplete spinal cord injury and available long-term follow-up.**

■ CONCLUSIONS: **Affordable neurosurgical care can be provided in a safe and sustainable manner to patients with traumatic spine and spinal cord injuries in resource-limited communities. This supports the call for essential neurosurgery to be made available around the world to individuals from all socioeconomic strata.**

INTRODUCTION

Spine trauma can result in devastating consequences for medical, social, emotional, and financial well-being, which are often more significant than consequences of other traumatic injuries.[1] Data on the epidemiology of spinal cord injury is required to inform the allocation of public health resources, including the development of primary prevention strategies and best practice programs. Crucially, suboptimal reporting and poor data quality have been linked to a lack of urgency in implementation of prevention policies and to higher rates of morbidity and mortality.[2,3] In recent years, the development of surgical capabilities in resource-poor countries has also been recognized as an indispensable part of health care and a global health priority.[4] In particular, trauma surgery has been identified as a key component of cost-effective "essential neurosurgery."[4,5] By preventing further neurologic worsening and affording an opportunity for neurologic recovery, spine trauma surgery has the potential to significantly impact quality of life even in resource-limited settings if the costs of treatment can be contained without sacrifices to safety and efficacy.

Following a vicious civil war and genocide that targeted the professional class in the late 1970s, killing a majority of the country's physicians, Cambodia is now rapidly developing and has recently been classified as a lower-middle-income economy by the

Key words
- Developing countries
- Fracture
- Resource limited
- Spine
- Spine surgery

Abbreviations and Acronyms
ASIA: American Spinal Injury Association
CT: Computed tomography
MRI: Magnetic resonance imaging
PKH: Preah Kossamak Hospital
WFNS: World Federation of Neurologic Surgeons

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World Bank Group. A neurosurgery department with a 30-bed capacity was established at our institution, Preah Kossamak Hospital (PKH), in 2010 and is currently staffed by 4 neurosurgeons.[6] As a major government hospital, we predominantly serve low-income inhabitants of Phnom Penh as well as patients from remote provinces around the Cambodian capital. Since the establishment of the Cambodia Neurosurgery Support Project in 2013, we have provided operative neurosurgical care to 699 patients at a cost of $100–$280 per surgery. We have also maintained a prospective database of cranial and spine procedures performed at PKH. A review of this database was performed to provide a report on the epidemiology of spine trauma in Cambodia and to add our surgical experience and outcomes to the global discussion on how neurosurgical care may be delivered to resource-limited communities.

MATERIALS AND METHODS

A retrospective review of a prospective neurosurgical database was performed to identify patients treated at PKH for cervical and thoracolumbar spine trauma from 2013 to 2016. Patients ≥18 years old who presented to PKH with acute spine injuries sustained within 2 weeks with or without neurologic deficits were included in this study. Patient demographics including age and sex, mechanism of injury, use of diagnostic imaging, treatment modality, and outcome measured by the American Spinal Cord Injury Association (ASIA) impairment scale were obtained. Cervical injuries were classified as minor fractures, burst fractures, teardrop fractures, traumatic disc herniations, and facet dislocations. Thoracolumbar injuries were classified as minor fractures, burst fractures, dislocation injuries, and translation injuries. Statistical analysis was performed using R Version 3.1.1 (R Foundation for Statistical Computing, Vienna, Austria; http://www.r-project.org). In univariable analysis, variables were compared between groups by Fisher's exact test for categorical variables and the Wilcoxon signed rank test for numerical variables. Statistical significance was defined as $P < 0.05$.

RESULTS

Epidemiology and Injury Characteristics

From 2013 to 2016, 277 patients were treated for cervical and/or thoracolumbar trauma at PKH. Patients were on average 40.2 ± 14.7 years of age. The median age was 38 years. The male-to-female ratio was 3:1. There were 71 cervical injuries (25.6%) and 206 thoracolumbar injuries (74.4%). Cervical injuries included 12 minor fractures (16.9%), 5 burst fractures (7.0%), 5 disc herniations (7.0%), and 36 facet dislocations (50.7%). Thoracolumbar injuries included 44 minor fractures (21.4%), 135 burst fractures (65.5%), 96 distraction injuries (46.6%), and 96 translation injuries (46.6%) (Table 1). Of patients with cervical trauma, 34 (49.3%), 8 (11.6%), 12 (17.4%), and 5 (7.2%) presented with ASIA A, ASIA B, ASIA C, and ASIA D neurologic deficits, and 10 (14.5%) were neurologically intact (ASIA E). Of patients with thoracolumbar trauma, 51 (25.0%), 20 (9.8%), 24 (11.8%), and 29 (14.2%) presented with ASIA A, ASIA B, ASIA C, and ASIA D neurologic deficits, and 80 (39.2%) were neurologically intact (ASIA E).

Table 1. Patient Demographics and Injury Characteristics (N = 277 Patients)

Characteristic	Value
Age, years, mean (range) [interquartile range]	40.2 (14–89) [28–50]
Sex	
Male	211 (76.2%)
Female	66 (23.8%)
Level of injury	
Cervical	71 (25.6%)
Thoracolumbar	206 (74.4%)
Subaxial injuries	
Compression fracture	12 (16.9%)
Burst fracture	5 (7.0%)
Teardrop fracture	3 (4.2%)
Disc herniation	5 (7.0%)
Facet dislocation	36 (50.7%)
Unilateral perched facet	0 (0.0%)
Unilateral jumped facet	2 (5.6%)
Bilateral perched facets	4 (11.1%)
Bilateral jumped facets	24 (66.7%)
Thoracolumbar injuries	
Compression fracture	44 (21.4%)
Burst fracture	135 (65.5%)
Distraction injury	96 (46.6%)
Translation injury	96 (46.6%)

Motor vehicle accidents (31.3%) and falls (51.4%) were the leading causes of both cervical and thoracolumbar trauma. Spine trauma from motor vehicle accidents was most frequently sustained by motorcyclists (66.7%). Falls causing thoracolumbar trauma were predominantly work-related, including falls at construction sites (32.9%) and from palm and mango trees (34.3%). Assault (0.7%) was a rare cause of spine trauma in and around Phnom Penh (Table 2). We did not identify any statistically significant predictors of severe spinal cord injury (ASIA A or ASIA B), including high-level falls from >15 feet, although there was a trend toward statistical significance for an association between falls and severe cervical spinal cord injury ($P = 0.0529$). Work-related spine trauma resulted in severe spinal cord injury in 40 patients (37.0%).

Management

Surgical treatment was performed for 65 patients (67.7%) with incomplete (ASIA B, ASIA C, or ASIA D) spinal cord injuries and 60 patients (70.6%) with complete (ASIA A) spinal cord injuries. Surgical cost, excluding the costs of implants and hospitalization,