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Water sport-related spine injury in Bali: a review and preliminary study



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ABSTRACT

Background: Spinal Injury is a devastating injury with life-long impact on an individual's health and quality of life. Sporting activities, such as water sport, is also known contributed to the spinal injury. This study aims to evaluate the water sport-related spine injury (WS-RSI), which is occurred in Bali during 2017 as a preliminary study at BROS Hospital.

Methods: A cross-sectional study was conducted retrospectively among 55 patients who got an injury during water-sport activity in 2017 and admitted to BROS Hospital, Denpasar, Bali by medical records. There was 28 patient-related spine injury. Demographic status regarding age, sex, length of stays, haemoglobin (Hb), random blood glucose, nationality, country origin, treatment, patient's status, history of alcohol intake, type of water sport, and the location of spine injury were recorded. Data were analyzed using SPSS version 25 for Windows in mean±SD, percentage, and odds ratio (OR) as well as statistically significant if P-value less than 0.05.

Results: Indonesian travellers were predominant in WS-RSI

(53.6%), followed by China and Australia (17.9%), India, Japan, and European countries (3.6%, respectively). The average age of patients was higher in spine injury (47.89±15.98 years; P=0.047). Both sexes were equal (50%). There was no significant difference in Hemoglobin (Hb) (11.08±1.30 g/dL) and random blood glucose (100.65±21.37 mg/dL) (P>0.05) levels. However, there was a significant difference among nationality, type of treatment, patient's status, and type of WS-RSI compared with non-spine injury (P<0.05). Based on variables, banana boat, foreign travellers, conservative treatment, and outpatient status were having a higher risk in WS-RSI (OR= 4.275; 5.143; 5.014; 7.389; P<0.05, respectively).

Conclusion: As a preliminary study, recent findings at BROS Hospital, Denpasar, Bali suggest that several factors are having a higher risk towards water sport-related spine injuries such as older age, banana boat, foreign travellers, conservative treatment, and outpatient status.

Keywords: BROS Hospital, Spine Injury, Water Sport, Risk Factors

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INTRODUCTION

Bali is one of the favourite destinations among international travellers. Numbers of international travellers visited Bali from January-November 2017 was 5.38 million travellers. Based on country, China was the leading number about 25.54% , followed by Australia (18.87%), India (4.53%), Great Britain (4.25%), United States (3.30%), France (3.17%), Germany (3.15%), South Korea (3.12%), and Malaysia (2.88%).¹ The attraction of Bali that had interested the travellers, including the beauty of nature, culture, and culinary variety that relatively typical. Diverse types of tourism destination of Bali starting from the beach, rice fields terraces, forest and lake areas, volcanoes, waterfalls, and artificial tourism areas such as tourist villages are also well known. One of the most activity of travellers in Bali is water sport. As temperatures climb in summer

months, involvement in water recreation activities including banana boating, parasailing and kayaking increases as well.¹

Spinal Injury is a devastating injury with life-long impact on an individual's health and quality of life. The epidemiological study updated in 2011, the global incidence rate of traumatic spinal cord injury (TSCI) is estimated at 23 per million or 179,312 new TSCI cases per year.² Spinal cord injuries are most common following high-energy mechanisms, which are involved with numerous recreational activities. These include contact sporting activities, motorized vehicle operation, and falls. On coastal waters, a variety of recreational activities exist that carry a predisposition to spinal cord and other traumatic injuries.³ These include surfing, personal motorized watercraft operation (i.e., riding a wave-runner or boating), swimming, kayaking,

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and bodysurfing. Injuries often occur following these activities due to the high-force nature of these mechanisms combined with the possibility that the event may occur in shallow water near the shoreline, which can lead to headfirst encounters with the ocean floor.^{4,5}

Though the aetiology of traumatic SCI has been reported to be most commonly due to motor vehicle accidents and falls, sports injuries also play a substantial role in causing SCI.⁵ Little information is available concerning water sport-related spine injury (WS-RSI) in Bali. Based on those mentioned above, this study aims to evaluate the water sport-related spine injury (WS-RSI) which is occurred in Bali during 2017 as a preliminary study at Bali Royal (BROS) General Hospital.

METHODS

Study Selection

A cross sectional study was conducted retrospectively among 55 patients from medical records who got an injury during water-sport activity in 2017 and admitted to BROS Hospital, Denpasar, Bali. The inclusion criteria used in this study were injury from water-sport activities, anamnesis regarding the type of injury, location of injury, as well as physical evaluation and laboratory assessment that related to the risk of injury from secondary data. Based on inclusion criteria, there were 28 patient-related spine injury and 27 patient-non related spine injury included in this study

Variable Assessment

Several parameters were evaluated from medical records in this study to determine the risk of spinal injury due to water-sport activities. Those parameters included demographic status regarding age (years), sex (female and male), length of stays (LOS) (days), haemoglobin (Hb) levels (g/dL), random blood glucose (RBS) (mg/dL), nationality (Foreign or Indonesia), country origin, types of treatment (conservative or surgical), patient's status (outpatients or inpatients), history of alcohol intake, type of water sport (banana boat or rafting), and the location of spine injury (cervical or thoracolumbar).

Data Analysis

Data regarding several parameters mentioned above were analyzed using SPSS version 25 for Windows in mean, standard deviation, and percentage. Risk evaluation was determined using the odds ratio (OR) and 95% confidence interval (CI) for categorical variables. Statistical analysis used in this study was Chi-Square to determine the difference between both groups in categorical variables and

Independent-T test for numerical data due to data normally distributed. A P-value less than 0.05 was considered statistically significant.

RESULTS

From 55 patients following water sports injury who came to the BROS Hospital, there was 28 spine-related injury (50.9%) patients according to the medical records (Table 1). The patients with spine-related injury is significantly older (47.89 ± 15.98 years old) than non-spine-related injury ($P=0.047$). There is no statistically significant between females and males in both groups ($P=0.591$) (Table 1).

The laboratory assessment for patients after admission also found no statistically significant in haemoglobin (Hb) and random blood glucose (RBG) levels ($P>0.05$). Based on nationality, the foreign patients tend to be significantly higher contributed in the spine related injury about 18 (64.3%) compared with non-spine-related injury group (7 patients; 25.9%) ($P=0.007$). However, there is no significantly different in-country origin of international tourist between both groups ($P=0.744$) (Table 1).

Most cases of spine-related injury were treated conservatively (67.9%) compared with non-spine related injury (29.6%) ($P=0.007$). Cervical spine injury was the most frequent location in spine-related injury (57.1%). In addition, the outpatients were significantly predominant spine-related injury group (67.9%) ($P=0.007$). No significant difference was found in the history of alcohol intake between-group ($P=0.352$). However, banana boat as a type of water sport was significantly known as the more frequent cause of water-sport related spine injury (64.3%) ($P=0.015$) (Table 1).

According to the risk analysis of spine injury, several parameters were evaluated to determine which variables are prone to provide spine injury among patients who underwent water sport activities. The outpatients were 7.389 times significantly higher for spine injury compared with inpatients (95%CI: 2.214-24.657; $P=0.001$). The foreign travellers also 5.143 times significantly higher to get a spine-related injury (95%CI: 1.617-16.335; $P=0.007$) compared with domestic. The similar results also found in banana boat and conservative treatment whereas about 4.275 and 5.014 times significantly higher to get water-sport related spine injury compared with rafting and surgical treatment, respectively ($P<0.05$). However, there was no significant difference between alcohol intake and gender to the risk of water-sport related spine injury ($P>0.05$) (Table 2).

Table 1. Baseline characteristics of respondents from water sports injury between spine and non-spine injury group

Variables	Water Sports Injury (n=55)				P-value
	Spine Injury (n=28)		Non-Spine Injury (n=27)		
	Mean±SD	N (%)	Mean±SD	N (%)	
Age (Years)	47.89±15.98		37.81±20.38		0.047**
Sex (%)					
Female		14 (50.0)		11 (40.7)	0.591 ^b
Male		14 (50.0)		16 (59.3)	
Length of Stays (LOS) (Days)	1.71±1.30		3.44±1.88		0.000 ^{a*}
Hemoglobin (g/dL)	11.08±1.30		11.53±1.83		0.365 ^a
Random Blood Glucose (mg/dL)	100.65±21.37		105.67±27.80		0.456 ^a
Nationality (%)					
Foreign		18 (64.3)		7 (25.9)	0.007 ^{b*}
Indonesia		10 (35.7)		20 (74.1)	
Country origin (%)					
China		5 (17.9)		4 (14.8)	0.744 ^b
Australia		5 (17.9)		2 (7.4)	
India		1 (3.6)		2 (7.4)	
Japan		1 (3.6)		1 (3.7)	
Europe		1 (3.6)		3 (11.1)	
Indonesia		15 (53.6)		15 (55.6)	
Treatment					
Conservative		19 (67.9)		8 (29.6)	0.007 ^{b*}
Surgical		9 (32.1)		19 (70.4)	
Patient's status					
Outpatient		19 (67.9)		6 (22.2)	0.001 ^{b*}
Inpatient		9 (32.1)		21 (77.8)	
Alcohol Intake					
Yes		1 (3.6)		3 (11.1)	0.352 ^b
No		27 (96.4)		24 (88.9)	
Location of Spine Injury					
Cervical		16 (57.1)		-	
Thoracolumbar		12 (42.9)			
Water Sport					
Banana boat		18 (64.3)		8 (29.6)	0.015 ^{b*}
Rafting		10 (35.7)		19 (70.4)	

^aIndependent T-Test; ^bChi-Square; SD: standard deviation; *P-value less than 0.05 was considered statistically significant

Table 2. Risk of spine injury based on demographic data of travellers

Variables	Spine Injury		OR	95% CI	P-Value
	Yes (n=28)	No (n=27)			
Gender					
Female	14 (50.0)	11 (40.7)	1.455	0.501-3.227	0.591
Male	14 (50.0)	16 (59.3)			
Water Sport					
Banana Boat	18 (64.3)	8 (29.6)	4.275	1.379-12.252	0.015*
Rafting	10 (35.7)	19 (70.4)			
Nationality					
Foreign	18 (64.3)	7 (25.9)	5.143	1.617-16.335	0.007*
Domestic	10 (35.7)	20 (74.1)			
Treatment					
Conservative	19 (67.9)	8 (29.6)	5.014	1.595-15.758	0.007*
Surgical	9 (32.1)	19 (70.4)			
Alcohol Intake					
Yes	1 (3.6)	3 (11.1)	0.296	0.029-3.042	0.352
No	27 (96.4)	24 (88.9)			
Patient's status					
Outpatient	19 (67.9)	6 (22.2)	7.389	2.214-24.657	0.001*
Inpatient	9 (32.1)	21 (77.8)			

OR: Odds Ratio; CI: Confidence Interval; *: statistically significant if p-value less than 0.05

DISCUSSION

Based on the baseline characteristic of respondents, variables that have significant value with $p < 0,05$ are age, length of stays, nationality, treatment, patient's status, and type of water sport. Based on risk of spine Injury based on demographic data, variables that have significant value with $p < 0,05$ are type of water sport, nationality, treatment and patient's status. Previous studies of bodysurfers sustaining a wave-related accident (WRA) report an older age group (40 to 46 years).⁶ The finding is similar to this preliminary study with a mean of age of 47.89±15.98 years. Meanwhile, study that conducted by Ye C. et al. in Beijing shows younger age group of WS-RSI incidence with the mean age was 24.49±11.92 years where diving was constituted 59.6% of the total incidence.⁷⁻¹⁰

Koyanagi et al. suggest that degenerative changes of the cervical spine, such as cervical spondylosis and cervical ossification of the posterior longitudinal

ligament (OPLL), and developmental narrowing of the spinal canal are important pre-existing factors for this type of injury.¹¹ This finding may explain why in this study we found a higher incidence of cervical spine injury compare with thoracolumbar spine injury. A study conducted by Kane et al. shows that cervical spine injury was dominant site of spine injury. A previous study suggests that spinal cord injury was almost exclusively due to cervical injuries; however no significant between-group differences were found for thoracic, lumbar, and sacral injuries.¹²

This study found that foreign tourist has higher incidence of injury compare with domestic tourist. That finding may caused by lack of knowledge and lack of communication from foreign tourist to their water sports instructors. Chalmers and Morrison reported that lack of knowledge and inexperience of the watersports participant is a risk factor for injury.¹³ Study by Ye C et al. suggest the main underlying cause of the accident was the lack of safety awareness, safety regulations, and their implementation.⁷

This study found that conservative treatment and outpatient patients are predominant with OR 5,014 and 7,389, respectively. The previous study shows that with conservative treatment, about 20–30% of all persons presenting within two weeks of spinal cord injury with complete injury improve 1–2 Frankel grades or more.^{14,15} About 50% of persons presenting with clinical complete cauda equina will walk again. Between 50 and 70% of patients with only distal sensory sparing recover walking and 75 to 80% of patients with insignificant distal motor sparing recover to walk again.^{14,15} Study about spine injury due to diving accidents by S. Aito et al. found that patients who underwent vertebral surgical fixation had a better neurological outcome: 44% of the surgically treated patients improved neurologically, while only 14% of those who received conservative treatment improved. The most type of injury is teardrop fractures, which are recorded in 40 patients (61%).¹⁶

This study found that alcohol intake does not associate with WS-RSI. This finding is not parallel with previous study that shows use of alcohol and other recreational substances also contributed to the observed pattern of injury. The number of intoxicated patients in the study cohort was higher than that in the control group (13.3% vs 7.6%, respectively) but not to a significant degree. Intoxicated vacationers are less inhibited and less coordinated, which could have led to the occurrence of the injury and additional compromise of the spinal cord.^{12,17}

This study found that the incidence of WS-RSI is dominant in banana boating activities. The

previous study suggests that falls and boating were less likely to result in spinal trauma and did not favour any specific region of the spinal column. “Banana boats” are large inflatable cylinders pulled behind speedboats, carrying up to eight passengers at a time. The excitement of the ride is heightened by increasing the speed and rate of turn of the speedboat. The manufacturers of commercial “banana boats” recommend a maximum towing speed of 15 miles/hour. Exceeded speed of banana boats could be the reason for any further accident of the passengers that could lead to spinal cord injury. We would suggest that passengers and operators of these crafts should be aware of the possible risks of injury if this speed is exceeded.¹⁸

CONCLUSION

This preliminary study regarding water-sport related spine Injury in Bali suggests that most cases are from foreign travellers. The banana boat was known as the primary water sport which has the highest contribution to the spine-related injury to the patients treated at BROS Hospital. Conservative therapy is the most common effort to manage water-sport related spine injury. However, a more significant number of samples and multicentre studies need to be carried out further in order to generalize the results of current study.

CONFLICT OF INTEREST

There is no competing interest regarding the manuscript

ETHICAL CLEARANCE

Ethics consideration has been obtained prior to the study being conducted from the Ethics Committee of Faculty of Medicine, Universitas Udayana, Bali and BROS Hospital

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AUTHOR CONTRIBUTION

I Ketut Suyasa and Anak Agung Wiradewi Lestari are responsible for the conceptual framework, data gathering, and preparation of the manuscript. I Putu Yuda Prabawa and Ketut Kris Adi Marta are responsible for data analysis and English improvement.

DISCLOSURE STATEMENT

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