

Santichatngam's Colonic Injury Prediction Score (SCOPES)

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Abstract

Background: Colonic injury is one of the common intra-abdominal organ injuries. The management of colonic injury has undergone many radical changes in the last few decades from all diversion to selected primary repair. So far, there has been no clinical predictive score for selection of treatment in patients with colonic injury.

Objective: To develop the clinical predictive score for treatment selection in patients with colonic injury.

Patients and Methods: Patients with colonic injury who were treated at Maharat Nakhon Ratchasima Hospital were recruited from Oct 1, 2008 to Sep 30, 2014. Retrospective chart review was performed.

Results: I developed the Santichatngam's Colonic Injury Prediction Score (SCOPES) using the following variables: weights; delayed time to surgery >6 hours (+2.56); gross fecal contamination (+4.19); left-sided colonic injury (+2.32); and duodenal/ureteral injury (+3.48). The positive SCOPES (score > 4.87 by >2 factors) had the following accuracy indices: sensitivity 88.24%; specificity 83.51%; likelihood ratio for positive results 5.35; and likelihood ratio for negative results 0.14. In validation phase, the probability of the SCOPES after a positive score was 84.25% for diversion and probability of the SCOPES after a negative score was 87.72% for primary repair.

Keywords: Clinical predictive score, colonic injury

INTRODUCTION

Colonic injury is one of the common intra-abdominal organ injuries and 90% of colonic injury is caused by penetrating injury. Penetrating colonic injury is the second most common penetrating intra-abdominal organ injury following the penetrating small bowel injury. In contrast, in blunt abdominal injury, colonic injury is found around 2-5%¹⁻⁷. For penetrating colonic injury, 75% is from gunshot wound and 25% from stab wound⁸.

Gunshot abdomen with colonic injury accounts

for 25-30% of all gunshot abdominal injuries and it causes low mortality rate, about 2-12%⁹. But colonic injury with associated injuries and complications can increase mortality rate¹⁰⁻¹¹. The good outcome depends on the length of time from injury to surgery and the choice of proper management¹².

The management of colonic injury has undergone many radical changes in the last few decades. From 1951 to 2003, new era of treatment of colonic injury that had been changed from all diversion to selected primary repaired can reduce the colon-related mortality

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from 90 to 1.3%^{8,12-22}. Pros and cons evidences about indication for considering the choice of treatment include delay time to surgery (>6 hours), shock (mean arterial blood pressure (MAP) < 65 mmHg), gross fecal contamination, intraperitoneal blood > 1 L, left-sided colonic injury, severe colonic injury, organ injury > 2 systems, abdominal wall loss, and massive blood transfusion. Only duodenal and ureteral injuries are contraindication for primary repaired^{2-5,8,12-14,20,21-34}.

OBJECTIVE

To develop the clinical predictive score for treatment selection in patients with colonic injury.

MATERIALS AND METHODS

Study population

Colonic injury patients (ICD 10th: S365) were recruited from Maharat Nakhon Ratchasima Hospital (MNRH) from October 1, 2008 to September 30, 2013 (5 years) for patient characteristics and from October 1, 2013 to September 30, 2014 for the development of clinical predictive score.

Data collections

Demographic data was reviewed from medical records including type of injuries, sex, age, underlying diseases, time to operation (hours), preoperative and intraoperative blood pressure, Colonic Injury Score (CIS) according to American College of Surgeons (ACS), degree of fecal contamination, blood transfusion in the first 24 hours, sites of colonic injury, number of organ injuries, abdominal wall loss, duodenal/ureteral injury, damage control surgery, operative time (hours), complications and mortality. This study was approved by Ethical Committee Board of MNRH.

Statistical analysis

Multiple logistic regression was used to analyze the association of clinical variables and diversion. Each variable would be included in the model if it was found to be associated with diversion at $p < 0.1$ in univariate analysis. For each model, a backward stepwise procedure was applied to remove variables that were not associated with diversion ($p > 0.05$). For each score, a receiver operating characteristic (ROC) curve was drawn; the area under ROC curve was estimated. We compared the area under ROC curves for each

Table 1 Characteristics of the patients in diversion and primary repair groups (n =230)

	Group		p -value
	Diversion (n = 26) (%)	Primary repaired (n = 204) (%)	
Age ≥ 40 years	10 (38.5)	74 (36.5)	0.82
Underlying disease	2 (7.7)	10 (4.9)	0.63*
Gunshot or shotgun injuries	4 (15.4)	21 (10.3)	0.49*
Delayed time to surgery ≥ 6 hours	5 (19.2)	15 (7.4)	0.06*
Surgeon (staff)	8 (30.8)	31 (15.2)	0.06*
Preoperative shock	1 (3.8)	7 (3.4)	0.91*
Intraoperative shock	1 (3.8)	1 (0.5)	0.21*
Gross fecal contamination	23 (88.5)	37 (18.1)	< 0.001
Intraperitoneal blood ≥ 1 L	10 (38.5)	21 (10.3)	0.001*
Left side colonic injury	19 (73.1)	87 (42.6)	0.003
CIS ≥ 4	11 (42.3)	18 (8.8)	<0.001*
Organ injury ≥ 2 systems	11 (42.3)	18 (8.8)	<0.001*
Abdominal wall loss	1 (3.8)	1 (0.5)	0.21*
Duodenal/ureteral injury	10 (38.5)	13 (6.4)	<0.001*
Damage control surgery	3 (11.5)	5 (2.5)	0.049*
Operative time ≥ 4 hours	5 (19.2)	4 (2.0)	0.001*
Blood transfusion ≥ 4 unit in first 24 h	2 (7.7)	8 (3.9)	0.32*

*Fisher's exact test

Table 2 Factors associated with diversion: multiple logistic regression analysis in the derivation sample (n=160)

Factor	Coefficient	SE	p-value	OR(95%CI)
Delayed time to surgery > 6 hours	2.56	1.22	0.037*	12.92 (1.17-142.17)
Gross fecal contamination	4.19	1.05	<0.001*	66.11 (8.37-522.18)
Left side colonic injury	2.32	0.93	0.013*	10.13 (1.63-62.86)
Duodenal/ureteral injury	3.48	1.03	0.001*	32.44 (4.31-243.97)

* $p < 0.05$

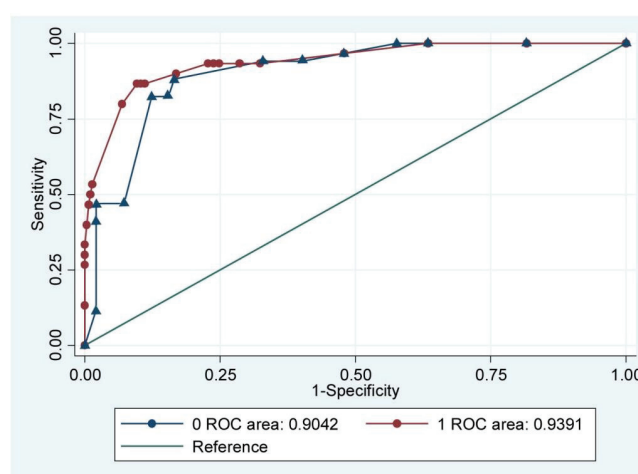
score. To develop a clinical predictive score, 70% of patients from October 1, 2008 to September 30, 2013 were recruited into the equation set score's performance using ROC curve analysis in the derivation phase. The rest (30%) were combined with the patients recruited from October 1, 2013 to September 30, 2014 to test the equation in the validation phase.

RESULTS

From October 1, 2008 to September 30, 2013, 230 patients with colonic injury were consecutively recruited. Univariate analysis was performed and shown in Table 1. Seven variables were analyzed with multiple logistic regression with derivation sample (n = 160). Four variables were associated with diversion in multivariate model (delay time to surgery > 6 hours, gross fecal contamination, left-sided colonic injury, and duodenal/ureteral injury) (Table 2).

Table 3 Final variable and its assigned scores in SCOPES

Factors	Scoring
Delayed time to surgery >6 hours	
Yes	2.56
No	0
Gross fecal contamination	
Yes	4.19
No	0
Left-sided colonic injury	
Yes	2.32
No	0
Duodenal/ureteral injury	
Yes	3.48
No	0
Total score	0-12.55

**Figure 1** Receiving operating characteristic (ROC) curve for SCOPES

and duodenal/ureteral injury) (Table 2). The Santichatngam's Colonic Injury Prediction Score (SCOPES) was developed using these variables in derivation sample as follows: weights; delay time to surgery > 6 hours (+2.56); gross fecal contamination (+4.19); left-sided colonic injury (+2.32); and duodenal/ureteral injury (+3.48) (Table 3). The area under the ROC curve was 0.9042 in the derivation and 0.9391 in the validation samples (Figure 1). The positive SCOPES (score > 4.87 by > 2 factors) had the following accuracy indices: sensitivity 88.24%; specificity 83.51%; likelihood ratio (LR) for positive results 5.35; and LR for negative results 0.14 in validation phase (Table 4).

The area under the ROC curve was 0.9042 in the derivation and 0.9391 in the validation samples.

Factors with $p < 0.1$ would be calculated with multiple logistic regression (delayed time to surgery,

Table 4 Score of diversion according to SCOPES category in derivation and validation phases

Score	Probability of diversion	Factors	Derivation (n=160)				Validation* (n=114)			
			Sensitivity	Specificity	LR+	LR-	Sensitivity	Specificity	LR+	LR-
>4.87	High	2 factors	86.67	88.97	7.8	0.1	88.24	83.51	5.3	0.1
7					5	5			5	4

*≥ 2 factors are the indication for diversion

Post test odd for SCOPES positive = 84.25%

Post test odd for SCOPES negative = 12.28%

surgeon, gross fecal contamination, intraperitoneal blood > 1 L, left-sided colonic injury, CIS ≥ 4, duodenal/ureteral injury).

Operative time ≥ 4 hours and damage control surgery were excluded because these factors were the surrogated outcome.

A score with range of 0-12.55 with a cut off at 4.87 (> 2 factors) is indication for diversion.

DISCUSSIONS

This study aimed to develop the colonic injury predictive score affecting the treatments of colonic injury, diversion or primary repair. I found the more important factors with statistical significance in the diversion treatment group than the primary repair group, including the delayed time to surgery > 6 hours ($P = 0.037$), gross fecal contamination ($p < 0.001$), left-sided colonic injury ($p < 0.013$) and duodenal/ureteral injury ($p < 0.001$). The delayed time to surgery is consistent with studies by Stone et al.^{4,25}, and George et al.³, but vetoed by the study of Kamwendo et al.³⁵. Gross fecal contamination was consistent with studies by Stone et al.^{4,25}, Demetriades et al.²¹, Hunt et al.²³, Nelkin et al.³⁰, George et al.³¹, and Ross et al.³⁶, but vetoed by studies by Burch et al.⁶ and Adkins et al.²⁷. Left-sided colonic injury is consistent with studies by Hunt et al.²³ but vetoed by studies by Thomson et al.²⁶. Duodenal/ureteral injury is consistent with studies by Huber et al.²⁰.

The cut point of SCOPES at 4.87 by factors > 2 has the sensitivity 88.24%, specificity 83.51%, positive LR 5.35 which is moderately increased in the likelihood of disease and negative LR 0.14 which is moderately decreased in the likelihood of disease (validation phase). The probability of SCOPES after a positive score is 84.25% for diversion whereas the probability

of SCOPES after a negative score is 87.72% for primary repair. I believe the SCOPES is the first novel study of the attempt of the systematic approach to treatment in the patients with colonic injury. The SCOPES has inherent advantages over the human clinical decision making. Firstly, the SCOPES can accommodate much more factors into consideration than the human brain. Secondly, the SCOPES will always give the consistent result whereas the human clinical judgment has been shown to have varied result in both consistency and disparity, especially with less experienced surgeons. Finally, the SCOPES has been shown to appear more accurate than clinical judgment alone.

CONCLUSIONS

Factors affecting treatment diversion or primary repair in colonic injury are the delayed time to surgery, gross fecal contamination, left-sided colonic injury and duodenal/ureteral injury. I have generated a novel score: SCOPES by factors > 2 that has the sensitivity 88.24%, specificity 83.51%. The SCOPES after a positive score has probability 84.25% for diversion. The SCOPES after a negative score has probability 87.72% for primary repair. The SCOPES will always give the accurate consistent result and has inherent advantages over human clinical decision making.

What is already known on this topic?

Previous studies in colonic injury patients has pros and cons associated with risk factors for diversion. So far there are no clinical predictive score for recommendation of treatment of choice in patients with colonic injury.

What is this study adds?

The SCOPE has inherent advantages over human

clinical decisions. It can accommodate many more factors to consider than the human brain and provide consistent results, especially in less experienced surgeons. In addition, it has more accuracy than clinical judgment alone.

Potential conflicts of interest

None.

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บทคัดย่อ **คะแนนทำนายวิธีการเกิดการบาดเจ็บของลำไส้ใหญ่โดยใช้ SCOPES****ปริญญ์ สันติชาติงาม****แผนกศัลยกรรม โรงพยาบาลมหาราชนครราชสีมา จังหวัดนครราชสีมา**

ภูมิหลัง: การบาดเจ็บของลำไส้ใหญ่พบได้บ่อยของอวัยวะบาดเจ็บในช่องท้อง การรักษามีการเปลี่ยนแปลงจากการผ่าตัดยก diversion มาสู่การ selected primary repair สามารถลดอัตราการตายที่เกิดจากการบาดเจ็บของลำไส้ใหญ่ ปัจจุบันยังไม่มีคะแนนทำนายวิธีการรักษาการบาดเจ็บของลำไส้ใหญ่

วัตถุประสงค์: เพื่อพัฒนาคะแนนทำนายวิธีการรักษาการบาดเจ็บของลำไส้ใหญ่

วัสดุและวิธีการ: ศึกษาย้อนหลังในผู้ป่วยการบาดเจ็บของลำไส้ใหญ่ (ICD 10th: S365) ที่โรงพยาบาลมหาราชนครราชสีมา ช่วงเวลา 1 ตุลาคม 2551 ถึง 30 กันยายน 2557

ผลการรักษาและสรุป: คะแนนทำนายวิธีการรักษาการบาดเจ็บของลำไส้ใหญ่ (SCOPES: Santichatngam's Colonic Injury Prediction Score) ได้ค่าคะแนนของปัจจัยดังนี้: delayed time to surgery > 6 ชั่วโมง (+2.56), gross fecal contamination (+4.19), การบาดเจ็บข้างซ้าย (+2.32), duodenal/ureteral injury (+3.18) จุดตัดค่าคะแนนเท่ากับ 4.87 คือตั้งแต่ 2 ปัจจัย sensitivity 88.24%, specificity 83.51%, likelihood ratio for positive results 5.35 และ likelihood for negative results 0.14 ในระยะ validation ความน่าจะเป็นในการเลือกวิธี diversion เมื่อคะแนนมากกว่าจุดตัดเท่ากับ 84.25% และความน่าจะเป็นในการเลือกวิธี primary repair เมื่อคะแนนน้อยกว่าจุดตัดเท่ากับ 87.72%
