The THAI Journal of SURGERY

Official Publication of The Royal College of Surgeons of Thailand

Vol. 46 October - December 2025 No. 4

The THAI Journal of SURGERY 2025;46(4):166-172.
Official Publication of The Royal College of Surgeons of Thailand

Original Article

Continuation Development Santichatngam's Colonic Injury Prediction Score (SCOPES) for Decision Making in Colonic Injuries due to Trauma

Prinya Santichatngam, MD[1]

Keerasak Jatwattanakul, MD[2]

[1] *Department of Surgery, Pranangklao Hospital*
[2] *Department of Surgery, Maharat Nakhon Ratchasima Hospital*

Abstract

Background: Primary repair, a method involving direct repair of colonic injuries, has emerged as a preferred treatment option. The development of the SCOPES scoring system has significantly enhanced decision-making regarding primary repair versus diversion procedures. SCOPES version I effectively predicts optimal patients for primary repair, while version II accurately identifies those requiring diversion. By providing a more systematic approach, SCOPES has reduced variability in clinical decision-making. Given the lack of a gold standard for managing colonic injuries, this study seeks to assess the clinical utility of SCOPES versions I, II, and III in patients with colonic injuries.

Patients and Methods: A four-year retrospective study was conducted involving 34 patients with colonic injuries from Pranangklao Hospital and Maharat Nakhon Ratchasima Hospital. Medical records were reviewed from October 2020 to September 2024.

Results: The majority of patients were working-age males with an average age of 38 years. Motor vehicle accidents were the primary cause of injuries, resulting in blunt trauma more frequently than penetrating trauma. The right colon was the most common site of injury. A comparison of primary repair and diversion procedures revealed that primary repair was associated with better outcomes and fewer complications. The study found that SCOPES version I was effective in predicting patients suitable for primary repair, although it had certain limitations. SCOPES versions II and III were more effective in predicting patients who required diversion compared to SCOPES version I. These versions demonstrated 100% sensitivity, specificity, accuracy, positive and negative predictive values, and had a significant impact on positive and negative likelihood ratios, diagnostic odds ratios, and posttest odds.

Conclusion: SCOPES versions II and III, designed for diversion procedures, outperformed SCOPES version I, which was developed for primary repair. These versions exhibited significantly better predictive accuracy compared to relying solely on clinical judgment or surgical judgment.

Keywords: Clinical prediction score, Colonic injury

Received for publication 21 May 2025; Revised 30 July 2025; Accepted 9 September 2025

Corresponding author: Prinya Santichatngam, MD, Department of Surgery, Pranangklao Hospital, 91 Nonthaburi Road, Bang Krasor Subdistrict, Mueang Nonthaburi District, Nonthaburi 11000, Thailand: E-mail: s_prinya@hotmail.com

https://doi.org/10.64387/tjs.2025.275562

Introduction

Current surgical management of colonic injuries has shifted away from routine colostomy.[1-11] Santichatngam's 2017 study introduced the Santichatngam's COlonic injury PrEdiction Score (SCOPES) as a tool to aid in surgical decision-making between primary repair and diversion procedures.[12] SCOPES version I (for primary repair) includes < 2 factors: delayed surgery time (> 6 hours), gross fecal contamination, left-sided colonic injury, and duodenum/ureter injury (grade > 3). A retrospective study by Banpot Wattakawanich and Prinya Santichatngam, conducted between 2013 and 2017 at Maharat Nakhon Ratchasima Hospital, evaluated the performance of the SCOPES in predicting outcomes of primary repair in patients with colonic injuries. While SCOPES demonstrated high sensitivity, specificity, and negative predictive value for predicting successful primary repair, its positive predictive value was relatively low. To improve the comprehensiveness of treatment recommendations, the study adjusted the Colonic Injury Severity Score (CIS) cutoff from ≥ 4 to ≥ 3.[13] A subsequent study by Prinya Santichatngam in 2022 evaluated the performance of both SCOPES versions I and II in patients with grade 3 or higher colonic injuries.[14] For SCOPES version II, diversion was recommended if more than one major factor was present, or if one major factor was accompanied by one or more minor factors. Major factors included gross fecal contamination and duodenum/ureter injury, while minor factors included delayed time to surgery (> 6 h) and left-sided colonic injury. The study compared the two versions, considering four factors for SCOPES version I. A primary repair was recommended if only one factor was present. For SCOPES version II, diversion was suggested if more than one major factor was present or if one major factor was accompanied by one or more minor factors. The study found that SCOPES version I had a sensitivity of 81%, specificity of 86%, positive likelihood ratio of 5.7, positive predictive value of 96%, and accuracy of 82% for predicting successful primary repair. SCOPES version II, on the other hand, demonstrated a sensitivity of 43%, specificity of 100%, positive likelihood ratio of greater than 10, positive predictive value of 100%, and accuracy of 90% for predicting the need for diversion. Overall, the use of both SCOPES versions could assist in making treatment decisions for up to 74% of patients with colonic injuries, potentially offering advantages over clinical judgment alone. The optimal management of colonic injuries remains a subject of ongoing debate, as there is no established gold standard treatment. This study aimed to determine the benefits of using SCOPES versions I, II, and III for patients with colonic injury in terms of sensitivity, specificity, accuracy, positive predictive value, and positive likelihood ratio.

Patients and Methods

A retrospective chart review was conducted at Pranangklao Hospital in Nonthaburi Province, a Level 2 Trauma Center under the Ministry of Public Health, and Maharat Nakhon Ratchasima Hospital in Nakhon Ratchasima Province, a Level 1 Trauma Center under the same ministry. The purpose of the study was to evaluate the diagnostic accuracy of SCOPES in patients with colonic injuries (ICD-10 codes: S365, S3650, S3651). The study included a total of 34 patients diagnosed between October 1, 2020, and September 30, 2024. Of these, 13 patients were from Pranangklao Hospital and 21 patients were from Maharat Nakhon Ratchasima Hospital.

Inclusion criteria

1. Age 15 years or older.
2. Underwent exploratory laparotomy.
3. Had a confirmed intraoperative diagnosis of grade 3 or higher colonic injuries.[9]

Exclusion criteria

1. Underwent damage control surgery.
2. Sustained iatrogenic injuries.
3. Had isolated rectal injuries (ICD-10: S36.6).

Baseline demographic data and clinical characteristics were collected, including type of injuries, underlying diseases, time to operation, colonic injuries score (CIS) according to the American college of surgeons (ACS),[9] degree of fecal contamination, sites of colonic injuries, grade of duodenal or ureteral injuries,[15,16] damage control surgery, details of the operative procedure, and operative complications. The criteria for SCOPES version III (for diversion) are as follows: These criteria are used in conjunction with SCOPES version II, meaning that if gross fecal contamination is present, diversion is recommended. All patients were assessed by two trauma surgeons who are board-certified, each having over two years of experience and subspecialty certification in trauma from the Medical Council of Thailand. These surgeons reviewed both the patient's condition and the operative notes. This study employed a peer review process requiring consensus between these two surgeons to establish a reference

standard for optimal treatment selection. In cases where the consensus of the peer reviewers differed from the treating physician's decision, the peer reviewers' joint assessment was considered the more suitable treatment option. The actual surgical treatments performed and the treatment recommendations generated by the SCOPES prediction score for colonic injuries were then compared against this reference standard (based on intraoperative findings and the final diagnosis). The predictive accuracy of the SCOPES scoring system for colonic injuries was assessed using a diagnostic test accuracy analysis. Sensitivity, specificity, positive and negative likelihood ratios, diagnostic odds ratio, overall accuracy, prevalence, and pretest and posttest odds were computed to evaluate the system's diagnostic performance. The research protocol has been reviewed and approved by the ethics committees of both Pranangklao Hospital, Nonthaburi, and Maharat Nakhon Ratchasima Hospital, ensuring adherence to ethical guidelines.

Results

Table 1 Demographic Data (N = 34)

Age (years) (mean) (SD) (range)	38.4 (16.02) (15-71)
Sex: male: female (%)	31 (91.2) : 3 (8.8)
Underlying disease	
HT (%)	1 (2.9)
DM (%)	3 (8.8)
Cause of injuries	
Blunt injuries	23 (67.6)
Penetrating injuries	
Non-gunshot or shotgun injuries	4 (11.7)
Gunshot or shotgun injuries	7 (20.6)
Length of stay (days) (median) (Interquartile range Q1-Q3)	11.5 (6.25-16)
Injury to operation (hours) (mean) (SD) (range)	13.35 (9.16) (2-41)
Preoperative shock (%)	1 (2.9)
Intraoperative shock (%)	0 (0)
Operative Time (hours) (mean) (SD) (range)	2.1 (0.88) (1-5)
Colonic injury grade: Grade 3 : Grade 4 : Grade 5 (%)	16 (47.1) : 8 (23.5) : 10 (29.4)
Side of colonic injuries: Right : Left : Both (%)	16 (47.1) : 15 (44.1) : 3 (8.8)
Associated intra-abbdominal organ injuries (Grading ≥ 3)	
Liver (%)	3 (8.8)
Stomach (%)	2 (5.9)
Duodenum (%)	3 (8.8)
Small bowel (%)	(23.5)
Degree of fecal contamination	
Mild to moderate contamination (%)	31 (91.2)
Gross or severe contamination (%)	3 (8.8)
Intraoperative blood transfusion* (units) (median) (Interquartile range Q1-Q3)	1 (0-2)
Estimate blood loss (ml) (median) (Interquartile range Q1-Q3)	425 (200-925)
Colonic management	
Primary repair (%)	28 (82.4)
Diversion procedure (%)	6 (17.6)
Outcome	
Survive (%)	32 (94.1)
Colonic-related complication	2 (5.9)

* Intraoperative blood transfusion refers to the administration of whole blood or packed red blood cells during a surgical procedure.

The number of patients with colon injuries (CIS > 3) from Pranangklao Hospital was 13, while Maharat Nakhon Ratchasima Hospital reported 21 patients. The average incidence of such injuries was 3.3 patients per year at Pranangklao Hospital and 5.3 patients per year at Maharat Nakhon Ratchasima Hospital. Of the total patients, 20 (58.8%) sustained injuries from road traffic accidents, 7 (20.6%) from gunshot wounds, 3 (8.8%) from sharp objects, 2 (5.9%) from falls from heights, 1 (2.9%) from being struck by a tree, and 1 (2.9%) from a saw. The locations of the colon injuries were as follows: cecum (7 patients, 20.6%), ascending colon (1 patient, 2.9%), hepatic flexure (1 patient, 2.9%), transverse colon (10 patients, 29.4%), splenic flexure (3 patients, 8.8%), and sigmoid colon (3 patients, 8.8%). Associated intra-abdominal injuries included liver injuries (grade 3 : 3 patients, 8.8%; grade 1: 1 patient, 2.9%), gastric injuries (grade 3 : 3 patients, 8.8%; grade 1: 1 patient, 2.9%; grade 2: 1 patient, 2.9%), duodenal injuries (grade 3 : 2 patients, 5.9%; grade 1: 1 patient, 2.9%), and small bowel injuries (grade 3 : 3 patients, 17.6%; grade 5 : 2 patients, 5.9%). Additional associated injuries included retroperitoneal hematoma (3 patients, 8.9%), diaphragmatic injuries (2 patients, 5.9%), pelvic fractures (2 patients, 5.9%), head injuries (2 patients, 5.9%), and a knee injury (1 patient, 2.9%). Please note that some patients have sustained injuries to multiple organs. Colonic-related complications observed included anastomotic leakage (1 patient, 3.6%) and stomal necrosis (1 patient, 16.7%). Causes of death among the patients included hospital-acquired pneumonia (1 patient, 2.9%), septic shock (1 patient, 2.9%), and severe head injury (1 patient, 2.9%).

Table 2 Comparison of actual colonic management and PEER review recommendations (N = 34)

		Actual surgical management	
		Diversion procedure	Primary repair
Reference Standard (PEER review)	**Diversion procedure**	2	1
	Primary repair	4	27

The actual management accuracy compared to PEER review recommendations was 85.29%.

Table 3 SCOPES version I (for primary repair) (N = 34)

		Reference Standard		Sensitivity (for primary repair)	Specificity (for primary repair)	Accuracy (for primary repair)	Positive predictive value	LR+
		Diversion	Primary repaired					
SCOPES version I	**Diversion procedure**	3	5	76.47	100	85.29	100	> 10 (large impact)
	Primary repair	0	26					

LR+: positive likelihood ratio

Negative predictive value is 37.50%. The negative likelihood ratio is 0.16, indicating a moderate impact. The diagnostic odds ratio exceeds 10, suggesting a large impact. The prevalence for primary repair is 91.18, with pretest odds of 10.34 and posttest odds indicating a large impact.

Table 4 SCOPES version II, III (for diversion procedure) (N = 34)

		Reference Standard		Sensitivity (for diversion procedure)	Specificity (for diversion procedure)	Accuracy (for diversion procedure)	Positive predictive value	LR+
		Diversion	Primary repaired					
SCOPES version II, III	**Diversion procedure**	3	0	100	100	100	100	> 10 (large impact)
	Primary repair	0	31					

LR+: positive likelihood ratio

Negative predictive value is 100%. The negative likelihood ratio is 0, indicating a large impact. The diagnosis odds ratio is greater than 10, also indicating a large impact. The prevalence of the diversion procedure is 8.82, while the pretest odds are 0.09. The posttest odds indicate a large impact.

Discussion

This study found that colonic injuries predominantly occurred in working-age individuals, with a mean age of 38.4 ± 16.02 years. Males were more frequently affected (91.2%) compared to females (8.8%), consistent with the findings of Brady and Oosthuizen.[17,18] Those with multiple comorbidities exhibited inferior treatment outcomes, corroborating the findings of Chamieh et al.[19] Blunt trauma was identified as the predominant mechanism of injury in this study, comprising 67.6% of cases. Road traffic accidents constituted 58.8% of the overall injuries. These findings deviate from previous research,[17,18] which has emphasized the significance of penetrating trauma. The majority of injuries were situated in the right side of the large bowel, with the transverse colon (29.4%), cecum (20.6%), ascending colon (2.9%), and hepatic flexure (2.9%) being the most frequently affected segments. This distribution is consistent with the observations reported by Sağıroğlu et al.[20] Falcone et al.[21] identified a constellation of risk factors associated with increased morbidity and mortality rates, including hypotension, massive transfusion, the extent of intra-abdominal contamination, concomitant organ injuries, shock, injuries to the left side of the colon, and the presence of multiple comorbidities. Within this study, preoperative shock was documented in 2.9% of patients, with no instances of intraoperative shock. The median volume of intraoperative blood transfusion was 1 unit, corresponding to a median estimated blood loss of 425 ml. Gross or severe fecal contamination was observed in 8.8% of cases. A significant proportion of patients (8.8%) sustained duodenal or ureteral injuries graded ≥ 3 in this study. Previous research has advocated for diversion procedures as a management strategy for injuries of this severity.[3,20] Colonic-related complications occurred in 3.7% of patients who underwent primary repair and 16.7% of those who underwent diversion procedures. These findings align with previous studies, which reported lower complication rates in the primary repair group, supporting the use of primary repair.[21-23] This study found an overall mortality rate of 5.9%, which is lower than the 9.9% reported by Burch JM and colleagues.[24] The accuracy of the surgical procedures executed by surgeons, as evaluated against the PEER review, was determined to be 85.29%. A previous study by Prinya Santichatngam[12] in 2017 identified factors affecting treatment diversion procedure or primary repair in colonic injuries, including delayed time to surgery, gross fecal contamination, left-sided colonic injuries, and duodenal or ureteral injuries (grade ≥ 3). The SCOPES version I, with factors > 2, demonstrated a sensitivity of 88.24% and specificity of 83.51%. A 2022 report revealed that SCOPES version I, designed for primary repair, exhibited a sensitivity of 81% and a specificity of 86%. In contrast, SCOPES version II, developed for diversion procedures, had a sensitivity of 43% and a perfect specificity of 100%.[14] This study demonstrated that while SCOPES version I (for primary repair) achieved a sensitivity of 76.47%, specificity of 100%, and accuracy of 85.29%. A study by Durham et al.,[25] identified gross or severe fecal contamination as a primary factor influencing treatment outcomes. In a more recent study by Jinescu et al.,[26] surgical judgment continues to play a pivotal role in decision-making. A multicenter study by Zeineddin et al.[27] proposed the use of the American Association for the surgery of trauma colon organ injury scale (OIS) to guide the management of colonic injuries. Studies by Durham,[25] Jinescu,[26] and Altiok[28] have proposed various scoring systems, including the abdominal trauma index (ATI) ≥ 30, colonic injury scale (CIS) ≥ 4, injury seriousness score (ISS), revised trauma score (RTS), and trauma injury severity score (TRISS), to guide treatment decisions for patients with colonic injuries. While these scoring systems aim to standardize treatment approaches, their implementation in clinical practice has encountered significant challenges. As a novel study, SCOPES versions II and III have demonstrated unparalleled accuracy and consistency in predicting outcomes for diversion procedures. With perfect sensitivity, specificity, positive or negative predictive value, positive or negative likelihood ratio or diagnosis odds ratio, or posttest odds, and accuracy, these models have significantly outperformed version I and traditional clinical judgment. This study provides strong evidence that SCOPES versions II and III offer a more reliable and consistent approach compared to traditional clinical judgment. applications.

Limitation

This hospital-based study was conducted at a trauma center to develop a new scoring system for surgical decision-making in colonic injuries with a colon injury scale (CIS) score > 3. Given the absence of a universally accepted gold standard for treatment recommendations, the study employed a PEER review process as the reference standard. As each participating hospital manages only approximately 3-5 such patients annually, refining surgical expertise through this system aims to facilitate the selection of more appropriate surgical treatments.

Conclusion

SCOPES versions II and III, developed for diversion procedures, have demonstrated exceptional performance in predicting outcomes, with perfect sensitivity, specificity, and accuracy. In contrast to primary repair surgery, which showed superior overall outcomes, SCOPES versions II and III significantly outperformed SCOPES version I, which was designed for primary repair. These findings highlight the reliability and accuracy of SCOPES versions II and III, making them valuable tools for clinical decision-making compared to traditional clinical or surgical judgment.

Conflict of Interest

No authors have any potential conflict of interest to disclose.

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