

Nomogram to Predict the Probability of Orthopedic Postoperative Constipation

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Research Article

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Abstract

Introduction: This study aimed to develop and validate a nomogram for predicting postoperative constipation(POC) in patients undergoing fracture surgery.

Materials and Methods: A total of 271 patients who underwent fracture surgery were retrospectively enrolled. Patients were categorized into constipation and non-constipation groups according to the occurrence of POC. Predictors were identified using Least Absolute Shrinkage and Selection Operator (LASSO) regression, with independent prognostic effects verified by multivariable logistic regression. A nomogram was constructed and developed using a training cohort (n = 190), then validated on a temporally and randomly split validation cohort (n = 81). Model performance was assessed via discrimination [area under the receiver operating characteristic curve (AUC-ROC)], calibration [Hosmer-Lemeshow test], and clinical utility [decision curve analysis (DCA) and clinical impact curves].

Results: The overall incidence of POC was 48.0% (130/271), with 89 cases (46.8%) in the training cohort and 41 cases (50.6%) in the validation cohort. Univariate analysis identified 16 variables with statistically significant differences between the constipation and non-constipation groups ($P < 0.05$), including duration of surgery, blood transfusion, and comorbidities. LASSO regression further selected eight factors—duration from surgery to discharge, age, comorbidity, intraoperative bleeding, blood transfusion, sufentanil, remifentanil, and propofol—as independent predictors of POC ($P < 0.05$). The nomogram incorporating these predictors yielded an area under the ROC curve (AUC) of 0.802 (95% confidence interval [CI]: 0.739–0.865) in the training cohort and 0.724 (95% CI: 0.611–0.838) in the validation cohort. Calibration curves demonstrated satisfactory agreement between predicted probabilities and observed outcomes in both cohorts.

Conclusions: The nomogram constructed based on these factors exhibits promising predictive performance and may serve as a practical tool for early risk stratification and individualized prevention of POC in clinical practice. Multi-center validation is needed to confirm its clinical utility.

Background

Postoperative constipation (POC) is a common yet often overlooked complication following surgical procedures, characterized by delayed defecation, abdominal distension, pain, and discomfort. The incidence of POC varies widely across surgical disciplines, ranging from 15% to 50%, and has been reported to be as high as 48–74% in orthopedic populations ^[1, 2]. In patients undergoing fracture surgery, POC not only causes significant physical discomfort but also leads to a series of adverse clinical consequences, including increased intra-abdominal pressure, impaired wound healing, delayed mobilization, prolonged hospital stay, elevated healthcare costs, and reduced quality of life ^[3, 4]. Moreover, severe POC may precipitate life-threatening complications such as intestinal obstruction, delirium in elderly patients, and increased risk of deep vein thrombosis due to prolonged immobility ^[5, 6]. Despite its substantial impact on postoperative recovery, POC remains inadequately recognized and

undertreated in clinical practice. Given the high prevalence and deleterious consequences, early identification of patients at high risk for POC is of paramount clinical importance, as it would enable timely implementation of preventive strategies such as bowel regimens, early mobilization, and pharmacological interventions, thereby improving surgical outcomes and patient satisfaction.

Several studies have attempted to develop prediction models for POC in various surgical settings. Liu et al. [7] constructed a risk prediction model for POC in patients with osteoporotic thoracolumbar fractures undergoing percutaneous kyphoplasty, demonstrating the feasibility of risk stratification in specific fracture types. Yang et al. [8] employed machine learning algorithms to predict POC risk in middle-aged and elderly patients with lower limb fractures, achieving promising predictive performance. Guo et al. [9] further reported that preoperative geriatric nutritional risk index (GNRI) could predict POC after fixation of extracapsular hip fractures in older adults. However, these existing models have notable limitations^[10–12]: they are confined to specific fracture subtypes or surgical procedures, rely on relatively small sample sizes, lack external validation, or fail to incorporate comprehensive perioperative variables such as intraoperative anesthetic medications and fluid management. Importantly, no study has developed a practical and easy-to-use nomogram for predicting POC in a general orthopedic fracture surgery population that integrates both patient-related factors and surgery-related variables.

Therefore, this study focused on patients with fractures of the spine, joints, extremities, and pelvis. By systematically collecting relevant perioperative data, we conducted an in-depth analysis of the risk factors associated with postoperative constipation. A nomogram-based risk prediction model was developed and rigorously validated. We anticipate that this model will serve as a more precise and effective clinical assessment tool, thereby providing evidence-based guidance for perioperative bowel management in fracture patients. Ultimately, the findings may offer valuable insights and methodological references for the prevention and management of postoperative constipation in patients undergoing other types of surgical interventions.

Methods

Research participants

This retrospective cohort study enrolled patients who underwent fracture surgery in the Department of Orthopedics at Renmin Hospital of Wuhan University between September 2018 and September 2019. Inclusion criteria: (1) Traumatic fractures; (2) age between 16 and 85 years; (3) definitive diagnosis of limb, spinal, or pelvic fractures with planned surgical treatment; (4) complete medical records. Exclusion criteria: (1) long-term use of medications for gastrointestinal symptoms or constipation; (2) pregnancy; (3) patients with severe comorbidities involving vital organs (e.g., liver, kidney, heart, or brain) that preclude tolerance to surgery. This study was approved by the Ethics Committee of Renmin Hospital of Wuhan University (approval no. 2018K-C073) and registered with the Chinese Clinical Trial Registry (registration no. ChiCTR1900023756|<http://www.chictr.org.cn/>). Date of registration: 10/06/2019). This study adhered strictly to the principles outlined in the Declaration of

Helsinki. Informed consent was waived due to the retrospective nature of the study and the use of anonymized data.

A total of 283 patients with fractures were identified during the study period. Five patients were excluded owing to incomplete data, 3 due to sudden changes in clinical status, and 4 because of preoperative constipation medication use. Finally, 271 patients remained for study analysis.

Research methods

Clinical data of the patients were collected, and patients were assigned to a postoperative constipation group or a normal group based on the time to first postoperative bowel movement, with > 3 days or laxative/enema use within 72 hours being defined as constipation^[9].

Data collection

Patients' clinical data were collected from the electronic medical record system and surgical anesthesia system. Based on previous research experience, we collected the following potential variables associated with postoperative constipation, including ASA classification, length of hospital stay, age, sex, body mass index (BMI), preoperative sleep status, comorbidities, smoking history, alcohol consumption, anesthesia modality, surgical timing (morning, afternoon, or evening), duration of surgery, duration of anesthesia, intraoperative blood loss, blood transfusion requirement, intraoperative medications (sufentanil, remifentanil, dexmedetomidine, propofol, etomidate, sevoflurane, lidocaine, and ropivacaine), intraoperative fluid infusion, delirium, intraoperative hypotension, and postoperative complications.

Statistical Methods

Continuous variables were summarized as mean (SD) or median (IQR), interquartile range (IQR), depending on the normality of distribution assessed by the Shapiro-Wilk test. Categorical variables were expressed as counts and percentages. Comparisons between the training and validation cohorts were performed using the independent-samples t test or Mann-Whitney U test for continuous variables and the chi-square test or Fisher exact test for categorical variables, as appropriate.

To screen candidate predictors, we applied least absolute shrinkage and selection operator (LASSO) regression to select the most predictive variables for orthopedic postoperative constipation. The optimal regularization parameter lambda was determined via 10-fold cross-validation using the minimum criteria (lambda.min). Variables with nonzero coefficients at the selected lambda were retained for model construction.

Using the selected predictors, a multivariable logistic regression model was fitted, and a nomogram was constructed to provide a visual representation of the prediction model. Model performance was

evaluated in both the training and validation cohorts. Discrimination was assessed using the area under the receiver operating characteristic curve (AUC). Calibration was evaluated through calibration plots with the Hosmer-Lemeshow goodness-of-fit test. Decision curve analysis (DCA) was performed to assess the clinical net benefit of the nomogram at various threshold probabilities.

Analysis was performed using R version 4.2.2 (<http://www.Rproject.org>; The R Foundation, Vienna, Austria) and the Free Statistics software (version 2.1.1; Beijing FreeClinical Medical Technology Co., Ltd, Beijing, China). All tests were two-sided, and P values below 0.05 were taken as significant.

Results

Baseline characteristics of subjects

Figure 1 outlines the patient screening process. Among 283 initially enrolled cases, 12 were excluded for the following reasons: missing data (n = 5), changes in patient's condition (n = 3), preoperative use of study-related medications (n = 4). Consequently, 271 eligible patients were included in the final analysis. These patients were randomly split into a training cohort (n = 190) and a validation cohort (n = 81) via random split at a ratio of 7:3.

As summarized in Table 1, the overall incidence of postoperative constipation was 48.0% (130/271), with no significant difference between the training and validation cohorts (46.8% vs. 50.6%, P = 0.569). Baseline characteristics were comparable between the two groups. The mean age was 53.1 ± 16.1 years, and the majority of patients were male (52.0%). Most patients were classified as ASA grade II (63.8%) and underwent general anesthesia (78.6%). No statistically significant differences were observed between the training and validation cohorts across all baseline variables (all P > 0.05), indicating adequate balance after random splitting.

Nomogram construction

The LASSO regression analysis, optimized at $\lambda = 0.025$ (λ_{1se}) within one standard error of the minimum mean squared error (λ_{min}), identified 8 key predictors: Duration from surgery to discharge, age, comorbidity, bleeding, blood transfusion, sufentanil, remifentanyl, propofol. (Fig. 2A and B; Supplementary Table 3).

Supplementary Table 4 showed the association between predictors and orthopedic postoperative constipation in logistic regression mode. These variables were integrated into a nomogram (Fig. 3) using the logistic regression formula: Logistic (probability of orthopedic postoperative constipation) = $-3.387 + 0.071 \times (\text{Duration from surgery to discharge, day}) + 0.013 \times (\text{Age, year}) + 0.759 \times (\text{Comorbidity, present} = 1) + 0.000 \times (\text{Bleeding, mL}) + 0.795 \times (\text{Blood transfusion, yes} = 1) + 0.011 \times (\text{Sufentanil, ug}) + 0.001 \times (\text{Remifentanyl, ug}) + 0.002 \times (\text{Propofol, mg})$.

Nomogram validation

The AUC was 0.802 (95% CI, 0.739–0.865) in the training cohort and 0.724 (95% CI, 0.611–0.838) in the validation cohort, indicating acceptable to good discrimination (Fig. 4 and Table 2).

Calibration curves were generated with 1,000 bootstrap resamples in both cohorts. In the training cohort, the calibration plot demonstrated close proximity of the predicted probabilities to the ideal diagonal line (Fig. 5A). In the validation cohort, the calibration curve remained well aligned with the reference line, with slightly wider confidence intervals at the extremes (Fig. 5B). The calibration slope and intercept did not significantly deviate from 1 and 0, respectively, in either cohort.

Decision curve analysis (DCA) was employed to explore the potential clinical utility of the nomogram (Fig. 6A and B). The analysis suggested that, across threshold probabilities of 6–82% in the training set and 7–68% in the validation set, using the nomogram to guide theoretical clinical decisions might offer a greater net benefit compared to simplistic “treat-all” or “treat-none” strategies within this retrospective simulation framework.

Table 1
Baseline Characteristics of the Study Participants

Variable	Total (n = 271)	Training (n = 190)	Validation (n = 81)	P value
ASA classification, No. (%)				0.579
I	20 (7.4)	16 (8.4)	4 (4.9)	
II	173 (63.8)	119 (62.6)	54 (66.7)	
III	70 (25.8)	48 (25.3)	22 (27.2)	
IV	8 (3.0)	7 (3.7)	1 (1.2)	
Duration from surgery to discharge, day, mean (SD)	10.5 (6.2)	10.2 (6.1)	11.2 (6.5)	0.202
Sex, No. (%)				0.569
Male	141 (52.0)	101 (53.2)	40 (49.4)	
Female	130 (48.0)	89 (46.8)	41 (50.6)	
BMI, mean (SD)	24.1 (3.6)	24.2 (3.5)	23.7 (3.8)	0.278
Age, y, mean (SD)	53.1 (16.1)	54.1 (16.0)	51.0 (16.2)	0.148
Education, No. (%)				0.575
Illiterate	19 (7.0)	12 (6.3)	7 (8.6)	
Primary/Junior high	131 (48.3)	97 (51.1)	34 (42.0)	
Secondary/High/Junior college	64 (23.6)	43 (22.6)	21 (25.9)	
College/University or above	57 (21.0)	38 (20.0)	19 (23.5)	
Usual sleep condition, No. (%)				0.782
Poor	38 (14.0)	28 (14.7)	10 (12.3)	
Fair	116 (42.8)	79 (41.6)	37 (45.7)	
Good	117 (43.2)	83 (43.7)	34 (42.0)	
Comorbidity, No. (%)				0.123
No	172 (63.5)	115 (60.5)	57 (70.4)	
Yes	99 (36.5)	75 (39.5)	24 (29.6)	

Note: Data are presented as mean (SD), median (IQR), or No. (%). SD = standard deviation; IQR = interquartile range; BMI = body mass index; ASA = American Society of Anesthesiologists. P values were derived from the independent-samples t test, Mann-Whitney U test, chi-square test, or Fisher exact test as appropriate.

Variable	Total (n = 271)	Training (n = 190)	Validation (n = 81)	P value
Smoking, No. (%)				0.538
No	206 (76.3)	143 (75.3)	63 (78.8)	
Yes	64 (23.7)	47 (24.7)	17 (21.2)	
Alcohol use, No. (%)				0.764
No	204 (75.3)	144 (75.8)	60 (74.1)	
Yes	67 (24.7)	46 (24.2)	21 (25.9)	
Anesthesia type, No. (%)				0.922
General anesthesia	213 (78.6)	149 (78.4)	64 (79.0)	
Nerve block	13 (4.8)	10 (5.3)	3 (3.7)	
Epidural anesthesia	5 (1.8)	3 (1.6)	2 (2.5)	
General + nerve block	40 (14.8)	28 (14.7)	12 (14.8)	
Time slot of surgery, No. (%)				0.738
Morning	123 (45.4)	88 (46.3)	35 (43.2)	
Afternoon	111 (41.0)	75 (39.5)	36 (44.4)	
Evening	37 (13.7)	27 (14.2)	10 (12.3)	
Duration of surgery, min, mean (SD)	131.9 (78.2)	129.8 (73.2)	136.7 (89.0)	0.512
Anesthesia time, min, mean (SD)	163.4 (82.7)	162.7 (76.3)	164.9 (96.5)	0.844
Bleeding, mL, median (IQR)	100.0 (50.0-300.0)	150.0 (50.0-300.0)	100.0 (50.0-300.0)	0.420
Blood transfusion, No. (%)				0.757
No	228 (84.1)	159 (83.7)	69 (85.2)	
Yes	43 (15.9)	31 (16.3)	12 (14.8)	
Crystalloid, mL, mean (SD)	862.2 (416.9)	831.1 (394.9)	935.2 (458.9)	0.060
Colloid (> 1000 mg), No. (%)				0.130
No	210 (77.5)	152 (80.0)	58 (71.6)	
<i>Note: Data are presented as mean (SD), median (IQR), or No. (%). SD = standard deviation; IQR = interquartile range; BMI = body mass index; ASA = American Society of Anesthesiologists. P values were derived from the independent-samples t test, Mann-Whitney U test, chi-square test, or Fisher exact test as appropriate.</i>				

Variable	Total (n = 271)	Training (n = 190)	Validation (n = 81)	P value
Yes	61 (22.5)	38 (20.0)	23 (28.4)	
Sufentanil, ug, mean (SD)	22.9 (10.8)	22.8 (10.7)	23.0 (11.1)	0.924
Remifentanil, ug, median (IQR)	600.0 (400.0-1100.0)	600.0 (400.0-1100.0)	620.0 (400.0-1200.0)	0.943
Dexmedetomidine, ug, median (IQR)	0.0 (0.0–40.0)	0.0 (0.0–40.0)	0.0 (0.0–40.0)	0.769
Propofol, mg, median (IQR)	150.0 (75.0-400.0)	190.0 (76.2-437.5)	150.0 (75.0-400.0)	0.813
Sevoflurane, mL, median (IQR)	10.8 (7.2–18.0)	10.8 (7.2–18.0)	10.8 (7.2–21.6)	0.654
Etomidate, mg, median (IQR)	6.0 (0.0–10.0)	8.0 (0.0–10.0)	5.0 (0.0–10.0)	0.385
Lidocaine, No. (%)				0.447
No	257 (94.8)	181 (95.3)	76 (93.8)	
Yes	14 (5.2)	9 (4.7)	5 (6.2)	
Ropivacaine, mg, median (IQR)	75.0 (0.0–75.0)	75.0 (0.0–75.0)	75.0 (0.0–75.0)	0.897
Delirium, No. (%)				0.509
No	269 (99.3)	189 (99.5)	80 (98.8)	
Yes	2 (0.7)	1 (0.5)	1 (1.2)	
Intraoperative hypotension, No. (%)				0.055
No	207 (76.4)	139 (73.2)	68 (84.0)	
Yes	64 (23.6)	51 (26.8)	13 (16.0)	
Complication, No. (%)				0.963
No	217 (80.1)	152 (80.0)	65 (80.2)	
Yes	54 (19.9)	38 (20.0)	16 (19.8)	
Delayed defecation, No. (%)				0.569
No	141 (52.0)	101 (53.2)	40 (49.4)	
<i>Note: Data are presented as mean (SD), median (IQR), or No. (%). SD = standard deviation; IQR = interquartile range; BMI = body mass index; ASA = American Society of Anesthesiologists. P values were derived from the independent-samples t test, Mann-Whitney U test, chi-square test, or Fisher exact test as appropriate.</i>				

Variable	Total (n = 271)	Training (n = 190)	Validation (n = 81)	P value
Yes	130 (48.0)	89 (46.8)	41 (50.6)	
<i>Note: Data are presented as mean (SD), median (IQR), or No. (%). SD = standard deviation; IQR = interquartile range; BMI = body mass index; ASA = American Society of Anesthesiologists. P values were derived from the independent-samples t test, Mann-Whitney U test, chi-square test, or Fisher exact test as appropriate.</i>				

Table 2
Receiver Operating Characteristic Curve Analysis of the Nomogram for Predicting Orthopedic Postoperative Constipation

Cohort	AUC	95% CI	Youden Index	NPV (%)	PPV (%)	Sensitivity (%)	Specificity (%)
Training model	0.802	0.739–0.865	0.519	79.8	71.9	78.4	73.5
Validation model	0.724	0.611–0.838	0.382	69.2	69.0	70.7	67.5
<i>Note: AUC = area under the receiver operating characteristic curve; CI = confidence interval; NPV = negative predictive value; PPV = positive predictive value.</i>							

Discussion

In this retrospective cohort study, we developed and validated a nomogram for predicting postoperative constipation (POC) in patients undergoing fracture surgery. Among 271 included patients, the overall incidence of POC was 48.0% (130/271), which is consistent with previous reports in orthopedic populations^[13, 14]. Using LASSO regression coupled with multivariable logistic regression, eight predictors were identified and incorporated into the nomogram: age, comorbidity, duration from surgery to discharge, intraoperative bleeding, blood transfusion, sufentanil, remifentanil, and propofol. The nomogram demonstrated acceptable discriminatory performance, with an AUC of 0.802 (95% CI: 0.739–0.865) in the training cohort and 0.724 (95% CI: 0.611–0.838) in the validation cohort. Calibration curves showed good agreement between predicted and observed probabilities, and decision curve analysis confirmed the clinical net benefit of the model across a wide range of threshold probabilities. These findings suggest that our nomogram is a reliable and practical tool for early risk stratification of POC in fracture surgery patients.

The eight predictors in our nomogram can be broadly categorized into patient-related factors (age, comorbidity) and surgery-related factors (duration from surgery to discharge, bleeding, blood transfusion, and intraoperative anesthetic agents). Each predictor has plausible biological and clinical links to POC. Advanced age is a well-established risk factor for constipation, as aging is associated with reduced colonic motility, decreased rectal sensitivity, and impaired pelvic floor function^[15, 16]. Elderly patients also tend to have more comorbidities and take multiple medications, further increasing the risk

of POC. The presence of comorbidities, particularly diabetes mellitus and neurological disorders, can disrupt the autonomic innervation of the gastrointestinal tract and slow colonic transit^[17, 18]. A longer duration from surgery to discharge reflects a more complicated postoperative course characterized by prolonged immobility, delayed resumption of oral intake, and greater opioid consumption, all of which predispose patients to constipation^[19, 20]. Intraoperative bleeding and blood transfusion are surrogate markers of surgical trauma and hemodynamic instability. Significant blood loss can lead to splanchnic hypoperfusion and intestinal mucosal ischemia, impairing gastrointestinal motility^[21]. Blood transfusion itself may trigger systemic inflammatory responses that further affect gut function^[22]. The inclusion of intraoperative opioids (sufentanil and remifentanil) and propofol as predictors warrants particular attention. Opioid-induced constipation (OIC) is a well-documented phenomenon mediated primarily by μ -opioid receptors in the enteric nervous system, which inhibit peristalsis, increase fluid absorption, and decrease intestinal secretion^[23–25]. Propofol, while primarily an anesthetic agent, may also exert inhibitory effects on gastrointestinal smooth muscle contractility through modulation of gamma-aminobutyric acid (GABA) receptors in the enteric nervous system^[26]. The identification of these anesthesia-related variables as independent predictors highlights the often-underappreciated role of intraoperative anesthetic management in the development of POC and suggests that anesthesiologists can play an active role in POC prevention through judicious selection of anesthetic agents^[27–28].

This study has several strengths. First, our model incorporates a wide range of perioperative variables, including detailed intraoperative anesthetic data, which are often overlooked in existing POC prediction models. Second, we employed LASSO regression for variable selection, which minimizes overfitting by shrinking coefficients and enhances the generalizability of the model. Third, the model performance was rigorously evaluated using multiple metrics, including AUC, calibration plots, and decision curve analysis, in both training and validation cohorts. The study also has several limitations that should be acknowledged. First, this was a single-center retrospective study with a relatively modest sample size ($n = 271$), which may limit the generalizability of the findings. The absence of external validation from an independent institution is a major limitation, and future studies should validate our nomogram in external cohorts. Second, the retrospective design may introduce selection bias and information bias, as data collection relied on medical records that were not originally intended for research purposes. Third, several potentially important variables were not collected in this study, including preoperative bowel habits, dietary fiber intake, use of laxatives postoperatively, postoperative mobilization status, and psychological factors such as anxiety and depression, all of which may influence POC risk. Fourth, the definition of POC in this study was based solely on the time to first bowel movement (> 3 days), without incorporating other validated constipation assessment tools such as the Rome IV criteria or the Constipation Assessment Scale (CAS). This may have led to misclassification of some patients.

In conclusion, we developed and validated a nomogram for predicting postoperative constipation (POC) in patients undergoing fracture surgery, based on eight readily available perioperative variables. The model showed acceptable discrimination, good calibration, and practical clinical utility, supporting its use for bedside risk stratification. By facilitating early identification of high-risk individuals, the

nomogram may enable timely implementation of targeted preventive measures—including prophylactic bowel regimens, early mobilization, judicious opioid-sparing analgesia, and dietary adjustments—thereby potentially reducing POC incidence and severity, shortening hospital length of stay, and improving overall postoperative recovery. Prospective multicenter studies with larger sample sizes and external validation are needed to confirm these findings and further optimize the model's predictive performance.

Abbreviations

POC: postoperative constipation; LASSO: least absolute shrinkage and selection operator; AUC: area under the receiver operating characteristic curve; DCA: decision curve analysis; BMI: body mass index; ASA: American Society of Anesthesiologists; CI: confidence interval; OIC: opioid-induced constipation; GABA: gamma-aminobutyric acid; ROC: receiver operating characteristic; NPV: negative predictive value; PPV: positive predictive value.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and was approved by the Ethics Committee of Renmin Hospital of Wuhan University (approval no. 2018K-C073). Informed consent was waived due to the retrospective nature of the study and the use of anonymized data. Additionally, The study protocol was retrospectively registered on the Chinese Clinical Trial Registry (ChiCTR1900023756|<http://www.chictr.org.cn/>) prior to data analysis on June 10, 2019, in compliance with WHO retrospective registration policies for observational studies.

Author Contribution

Zhuo Dong formulated the project, collected data, performed the analysis, and wrote the manuscript. Qianqian Qiao was involved in data collection, writing, and editing the manuscript. Lidan Huang was involved in data collection and editing the manuscript. Wenqin Song designed the project, performed the analysis ,edited the manuscript. Cheng Xu involved in data acquisition, general design of the trial, interpretation of the data, and critical revision of the manuscript.All authors gave final approval to the manuscript.

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Data Availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Figures

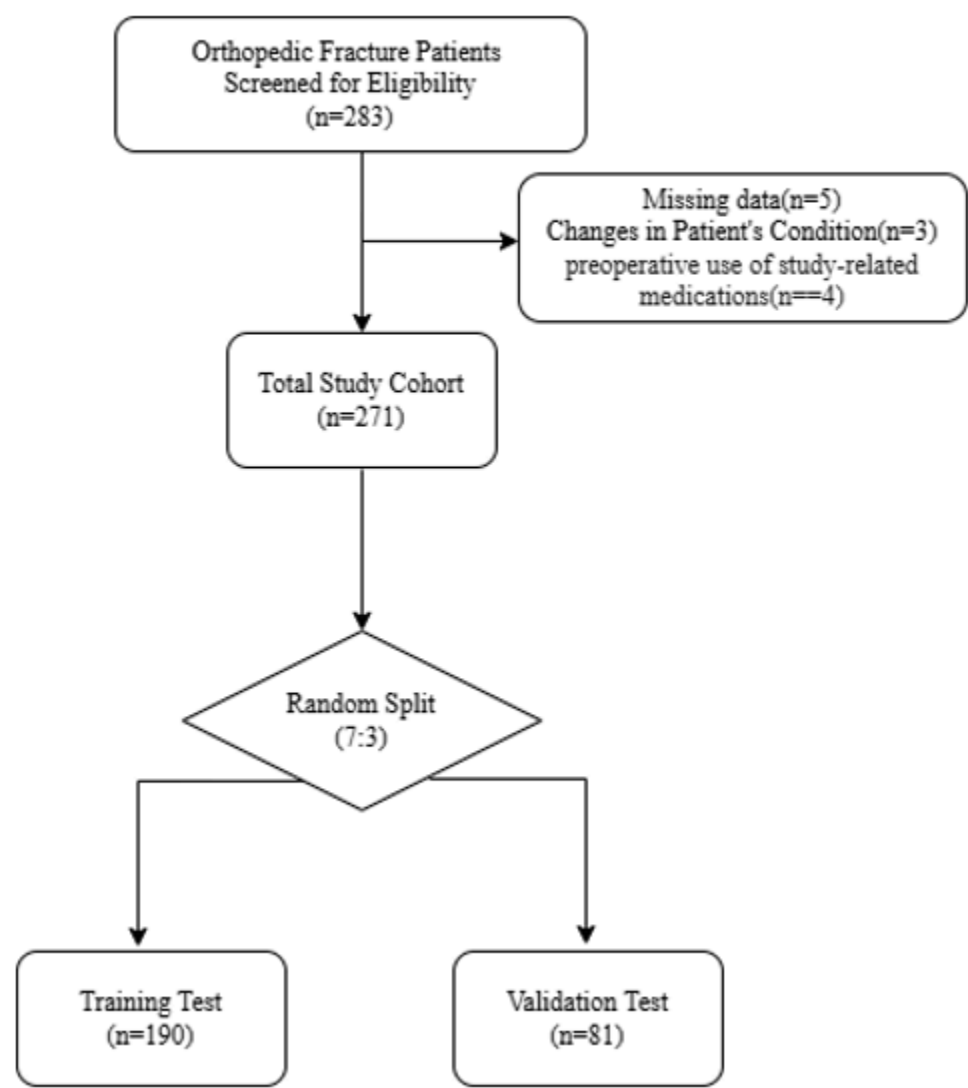


Figure 1

Flow diagram of patient selection processing.

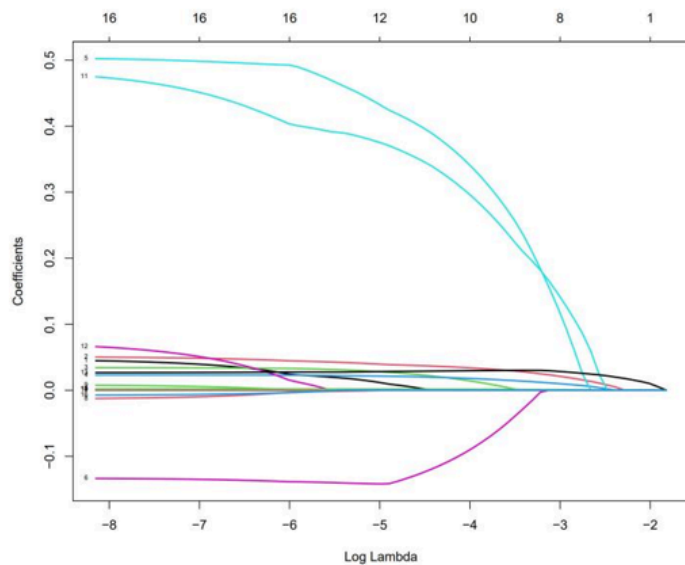


Figure 2(A)

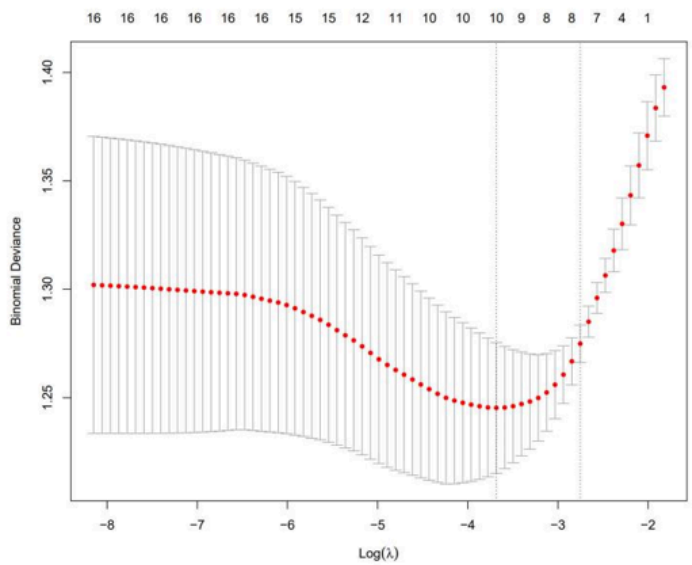


Figure 2(B)

Figure 2

Variable selection using the least absolute shrinkage and selection operator (LASSO) logistic regression model. (A) LASSO coefficient profiles of the 16 candidate variables. Each colored line represents the coefficient trajectory of a variable as the regularization parameter λ varies. The upper x-axis indicates the number of variables with nonzero coefficients at each λ value. The vertical dashed line marks the optimal λ selected by 10-fold cross-validation. (B) Sixteen candidate variables entered the LASSO regression. Following 10-fold cross-validation, 8 variables with nonzero coefficients were retained at the optimal λ value of 0.025. Final model retaining eight core variables: Duration from surgery to discharge, age, comorbidity, bleeding, blood transfusion, sufentanil, ropivacaine, propofol.

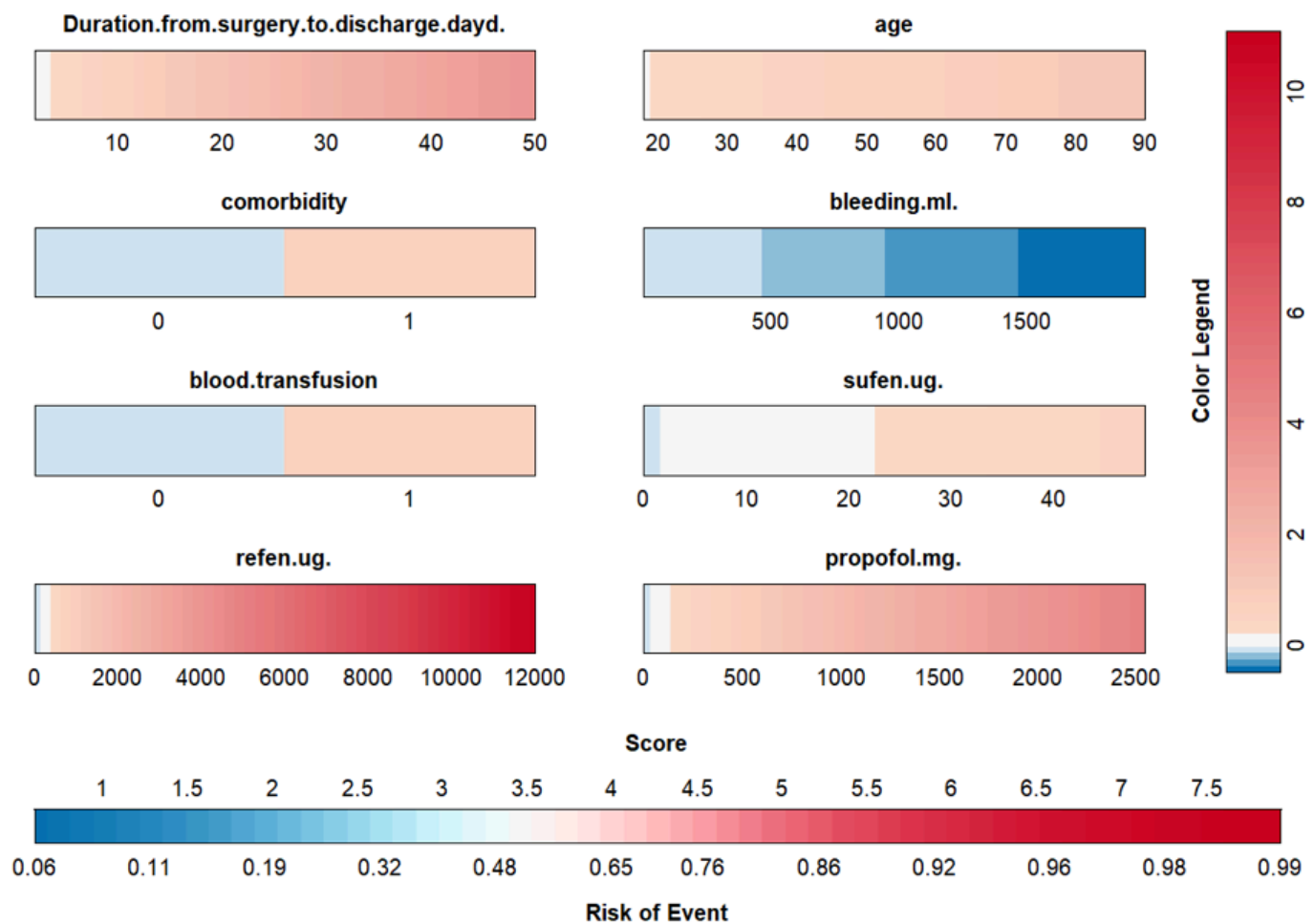


Figure 3

Nomogram to predict the probability of orthopedic postoperative constipation. According to nomogram, points for :Duration from surgery to discharge,age,comorbidity,bleeding,blood transfusion,sufen,refen,propofol can be calculated from line. Total points were the sum of the 8 points. And we can evaluate the risk of Orthopedic Postoperative Constipation from the last line according to the total point.

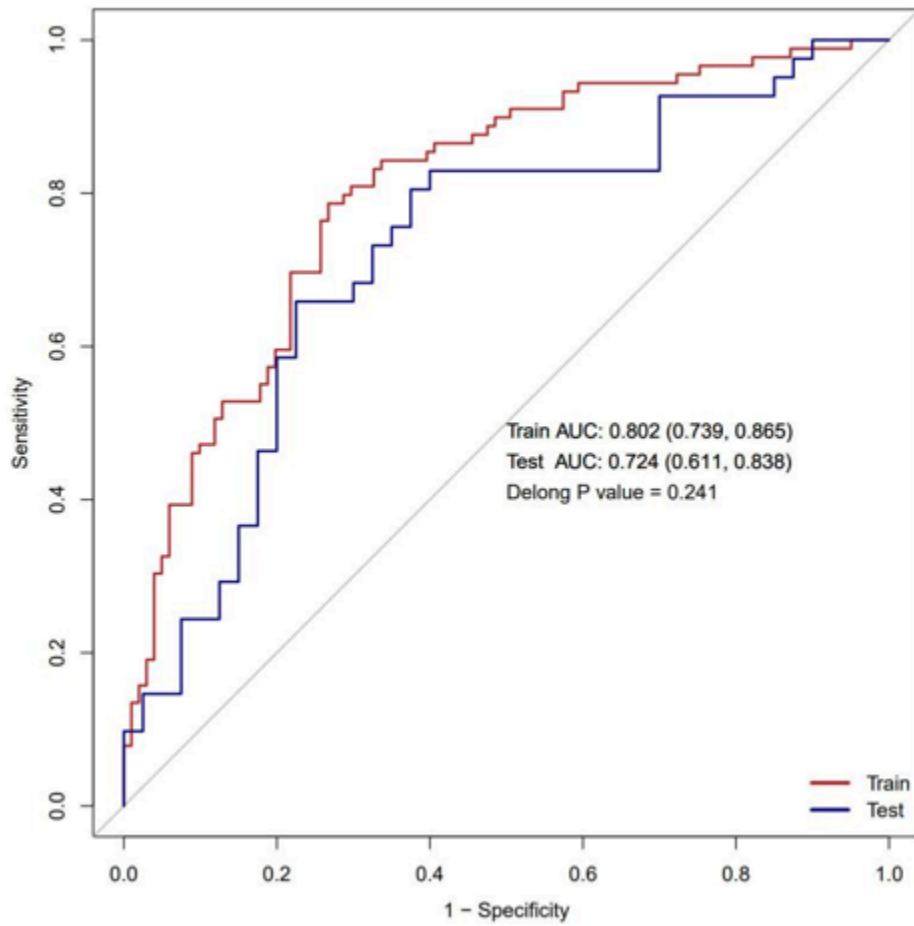


Figure 4

Receiver operating characteristic (ROC) curves for the nomogram in the training and validation cohorts.

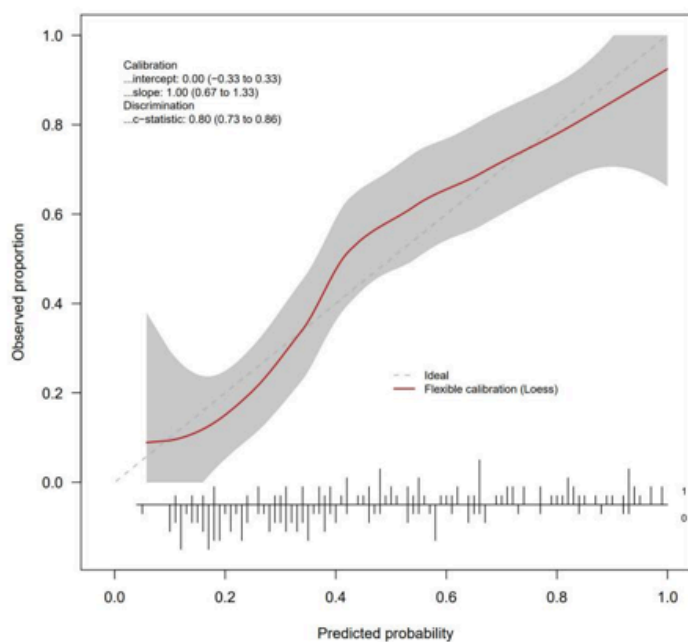


Figure 5(A)

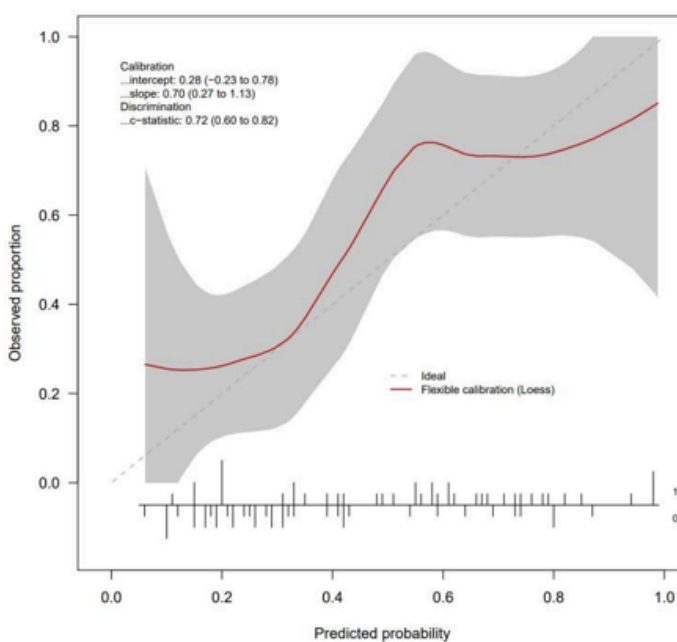


Figure 5(B)

Figure 5

Calibration curve for the nomogram to predict the probability of Orthopedic postoperative constipation with bootstrap sampling validation in the training cohort (A) and validation cohort (B). The dashed diagonal line represents the ideal prediction. The solid line indicates the actual performance of the nomogram. Closer alignment to the diagonal line indicates better calibration.

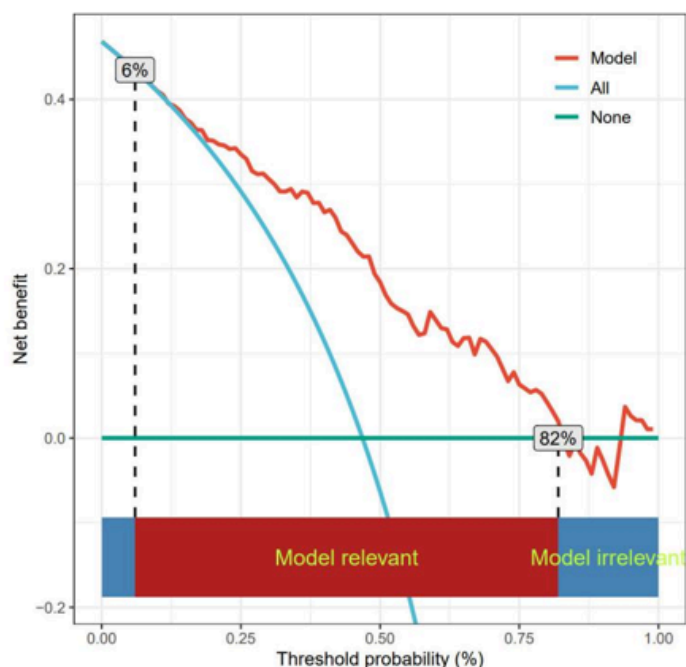


Figure 6(A)

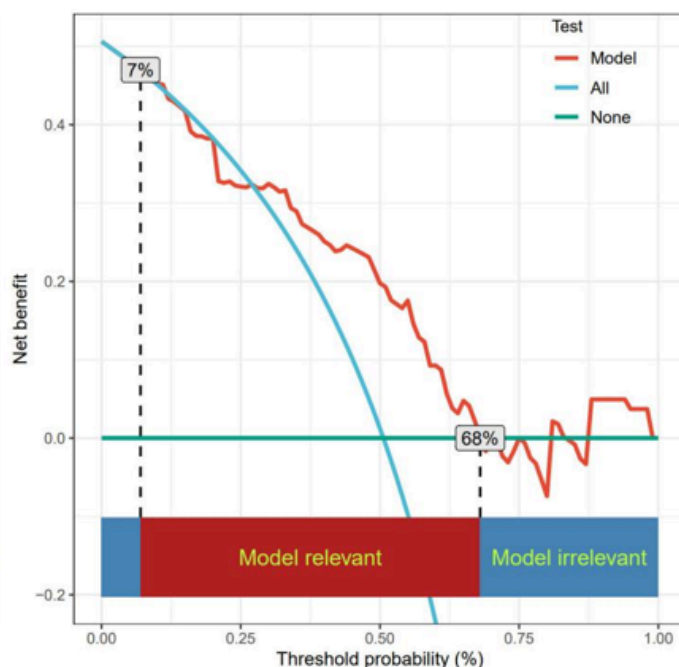


Figure 6(B)

Figure 6

Decision analysis curves showing the clinical usefulness of the nomogram prediction model in the training cohort (A) and validation cohort (B). The abscissa represents threshold probability, the ordinate represents net benefit for patients. The horizontal line represents no clinical benefit for all patients without prediction and intervention. The gray line represents the clinical benefit of intervention for all patients, and the blue curve represents the clinical benefit of using the nomogram prediction model.

Supplementary Files

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