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在线全文

骨质疏松性胸腰椎骨折患者经皮椎体后凸成形术后便秘风险预测模型的构建及验证*

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【摘要】 目的 构建骨质疏松性胸腰椎骨折（osteoporotic thoracolumbar fracture, OTLF）患者经皮椎体后凸成形（percutaneous kyphoplasty, PKP）术后便秘的风险预测工具。**方法** 选取2020年1月–2024年12月858例PKP术后的OTLF患者，随后将患者依照7∶3的比例分为训练集（n=600）和验证集（n=258）。根据患者术后是否便秘，将训练集分为便秘组（n=205）与无便秘组（n=395），将验证集分为便秘组（n=90）与无便秘组（n=168）。logistic回归分析OTLF患者PKP术后便秘的影响因素，并构建列线图模型，绘制该模型受试者工作特征（recciver operating characteristic, ROC）曲线和校准曲线，行Hosmer-Lemeshow拟合优度检验。**结果** 训练集有205例（34.17%）、验证集有90例（34.88%）OTLF患者PKP术后出现便秘。单因素分析显示，便秘组与无便秘组患者手术时间、术后饮水量、术后首次进食时间、术后卧床时间、双歧杆菌、乳酸菌、肠球菌、肠杆菌、NRS2002、钠、钾以及HbA1c水平差异存在统计学意义（P<0.05）；LASSO回归进一步筛选出手术时间、术后首次进食时间、双歧杆菌、乳酸菌、肠球菌、肠杆菌、NRS2002、钠、钾、HbA1c作为候选预测因素；多因素logistic分析显示：术后首次进食时间、双歧杆菌、乳酸菌、NRS2002、钠、HbA1c是OTLF患者PKP术后便秘的影响因素（P<0.05）；ROC曲线分析显示，训练集曲线下面积（area under the curve, AUC）为0.842〔95%置信区间（confidence interval, CI）：0.793～0.892〕，验证集AUC为0.860（95%CI：0.830～0.889）；校准曲线提示训练集与验证集的预测曲线与标准曲线基本拟合。**结论** 术后首次进食时间、双歧杆菌、乳酸菌、NRS2002、钠、HbA1c水平是OTLF患者PKP术后便秘的影响因素，基于上述因素构建的列线图模型具有一定效能。

【关键词】 骨质疏松性胸腰椎骨折 经皮椎体后凸成形术 便秘 列线图

Construction and Validation of a Risk Prediction Model for Postoperative Constipation in Patients With Osteoporotic Thoracolumbar Fracture Undergoing Percutaneous Kyphoplasty

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[Abstract] Objective To develop an instrument for predicting postoperative constipation risks in patients with osteoporotic thoracolumbar fracture (OTLF) who have undergone percutaneous kyphoplasty (PKP). **Methods** A total of 858 OTLF patients who underwent PKP surgery between January 2020 and December 2024 were enrolled. The patients were randomly assigned to a training set (n = 600) and a validation set (n = 258) in a 7∶3 ratio. According to whether the patients had postoperative constipation, the training set was divided into a constipation group (n = 205) and a non-constipation group (n = 395), and the validation set was divided into a constipation group (n = 90) and a non-constipation group (n = 168). Logistic regression analysis was conducted to analyze the factors influencing postoperative constipation in OTLF patients after PKP, and a nomogram model was constructed accordingly. The receiver operating characteristic (ROC) curve and the calibration curve of the model were plotted, and the Hosmer-Lemeshow test for goodness of fit was performed. **Results** A total of 205 OTLF patients (34.17%) in the training set and 90 OTLF patients (34.88%) in the validation set experienced constipation after PKP. Univariate analysis revealed significant differences between the constipation and non-constipation groups in terms of operative time, postoperative water intake, time to first postoperative meal, postoperative bed rest time, the levels of *Bifidobacterium*, *Lactobacillus*, *Enterococcus*, and *Enterobacter*, the Nutrition Risk Screening 2002 (NRS-2002) score, and the levels of sodium, potassium, and HbA1c (P < 0.05). Least absolute shrinkage and selection operator (LASSO) regression was performed and operative time, time to first postoperative meal, the levels of *Bifidobacterium*, *Lactobacillus*, *Enterococcus*, and *Enterobacter*, the NRS-2002 score, and

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the levels of sodium, potassium, and HbA1c were identified as candidate predictors. Multivariate logistic analysis showed that the time to first postoperative meal, the levels of *Bifidobacterium* and *Lactobacillus*, the NRS-2002 score, and the levels of sodium and HbA1c were influencing factors of postoperative constipation in OTLF patients ($P < 0.05$). The ROC curves showed that the area under the curve (AUC) of the training set was 0.842 (95% CI: 0.793-0.892), while that of the validation set was 0.860 (95% CI: 0.830-0.889). The calibration curves demonstrated good agreement between the prediction curve and the standard curve in both the training set and the validation set. **Conclusion** The time to the first postoperative meal, the NRS2002 score, and the levels of *Bifidobacterium*, *Lactobacillus*, sodium, and HbA1c are influencing factors of post-PKP constipation in OTLF patients. The nomogram model built based on these factors exhibited good predictive performance.

[Key words] Osteoporotic thoracolumbar fracture Percutaneous kyphoplasty Constipation Nomogram

骨质疏松性胸腰椎骨折(osteoporotic thoracolumbar fracture, OTLF)是骨质疏松症常见的并发症之一,其在老年人群中发病率较高[1]。研究数据显示[2-3],我国50岁以上人群骨质疏松症患病率约19.2%,OTLF占其中的30%~50%,且随着人口老龄化的加剧,发生率逐年上升的趋势。该疾病往往会出现强烈的背部疼痛,限制患者活动,造成功能障碍,导致患者生活质量下降[4]。目前,临床对于轻症患者多采用保守治疗,但是对于重症患者,手术治疗的总体预后优于保守治疗。经皮椎体后凸成形术(percutaneous kyphoplasty, PKP)是一种微创手术,能够有效缓解患者疼痛,帮助其恢复椎体高度,具有一定稳定性,已成为OTLF的一线治疗方案[5-6]。但是,术后并发症的防控仍是临床关注的重点。流行病学数据显示[7],便秘是一种常见的胃肠道症状,在术后患者中发生率高达35%~48%。CELIK等[8]研究表明,术后便秘不仅会延长患者住院时间,增加医疗成本,还有诱导肠梗阻发生的风险,严重不利于患者术后恢复。尽管现有研究已探讨出便秘的发生可能与麻醉、镇痛药物有关,但是针对OTLF患者PKP术后便秘的独立危险因素尚未系统分析,且缺乏专病化的风险预测工具。因此,构建并验证OTLF患者PKP术后便秘的风险预测模型,对优化围术期管理,改善患者预后具有重要意义。

基于此,本研究将选择行PKP术的OTLF患者,收集相关资料,深入分析其术后便秘的危险因素,建立列线图预测模型并验证,以期为临床提供一种更为精准、有效的评估工具和诊疗指导,进而优化OTLF患者PKP术后便秘围术期管理方案,并对其他疾病手术患者提供防治思路与方法。

1 资料与方法

1.1 一般资料

选取2020年1月–2024年12月858例PKP术后的OTLF患者,随后将患者依照7∶3的比例分为训练集(n=600)和验证集(n=258)。根据患者术后是否便秘,将训练集分为便秘组(n=205)和无便秘组(n=395),将验证集分为便秘组(n=90)和无便秘组(n=168)。纳入标准:①均符合OTLF诊断标准[9],且经影像学确诊;②均行PKP术治疗,且顺利完成;③年龄≥55岁;④术后意识清醒,无交流障碍;⑤便秘组符合《慢性便秘基层诊疗指南(2019年)》[10]便秘相关标准;⑥临床资料完整无缺失。排除标准:①非首次行PKP术;②外伤性、肿瘤性、结核性脊柱骨折;③手术禁忌证;④器质性胃肠功能障碍;⑤近期使用胃肠功能药物;⑥存在严重基础疾病;⑦主要脏器功能障碍;⑧严重代谢性疾病;⑨合并恶性肿瘤;⑩不能口进食者。本研究经本院伦理委员会批准通过(批准号RW-IACUC-24-0008),且符合《赫尔辛基宣言》[11]。

1.2 方法

1.2.1 资料收集

收集性别、年龄、病程、手术时间、麻醉方式、术后饮水量、术后镇痛泵、术后首次进食时间、术后卧床时间、便秘史、肠道菌群(双歧杆菌、乳酸菌、肠球菌、肠杆菌)。

1.2.2 营养风险

选取NRS2002量表[12],对其营养风险进行评估,其中,疾病严重程度计0~3分,营养受损程度计0~3分,年龄≥70岁计1分,分值与营养风险成正比。

1.2.3 血清指标

抽取患者清晨空腹血5 mL,采用医用离心机(Legend RT, D-37520型),以转速3 500 r/min,离心15 min,分离血清,置于—70 ℃环境下储存。应用全自动生化检测仪(迈瑞,BS240型)检测患者血清钠、钾、钙、镁离子以及C-反应蛋白(C-reactive protein, CRP)、糖化血红蛋白(glycosylated hemoglobin, HbA1c)水平。

1.3 数据处理

对所收集的数据进行质量检查,检查数据完整性、准确性和一致性。发现缺失或异常数据,根据实际情况采

取相应的补充、修正或删除措施，可使用均值或中位数等统计方法对缺失数据进行插值处理；如果数据缺失比例过高或数据异常情况严重，则需要将整个样本从分析中排除。对于异常值的识别，运用箱线图、四分位距进行检测，一旦识别出异常值，进一步调查以确认是否由数据输入错误或设备故障引起。若确认为异常值，根据具体情况决定是进行修正还是删除。为了使数据更符合分析需求，通过对数变换或Box-Cox变换等方法调整数据分布，使其更接近正态分布，从而提升分析的准确性。最后，根据分析的具体需求，还需对数据进行标准化、归一化处理。

1.4　统计学方法

SPSS 27.0分析数据，计量资料以$\bar{x}\pm s$表示，行t/F检验，计数资料以例数(%)表示，用χ^2检验。采用LASSO回归筛选OTLF患者PKP术后便秘的潜在预测因子，多因素logistic分析进一步筛选出独立预测因子，应用R 4.4.1建立列线图预测模型，以受试者工作特征(receiver operating characteristic, ROC)曲线检验模型区分度，绘制校准曲线及Hosmer-Lemeshow检验模型准确度，以十折交叉验证进行验证模型一致性，采用决策曲线分析评价模型的判别能力。P<0.05为差异有统计学意义。

2　结果

2.1　训练集与验证集患者基线资料

本次研究共纳入858例行PKP术的OTLF患者，划分为训练集600例、验证集258例。其中，训练集有205例(34.17%)、验证集有90例(34.88%)患者出现术后便秘现象。在训练集与验证集中，两组差异均无统计学意义，具备后续研究基础，见表1。

表 1　训练集与验证集患者基线资料

Table 1　Baseline data of patients in the training and validation sets

Factor	Training set (n = 600)	Validation set (n = 258)	χ^2/t	P
Sex/case (%)			0.126	0.723
Male	259 (43.17)	108 (41.86)		
Female	341 (56.83)	150 (58.14)		
Age/yr.	64.64 ± 6.33	65.12 ± 6.23	1.023	0.306
Course of disease/month	13.81 ± 4.46	13.78 ± 4.50	0.090	0.928
The surgery time/min	54.22 ± 3.76	54.14 ± 3.78	0.285	0.776
Anesthesia method/case (%)			0.049	0.961
General anesthesia	443 (73.83)	190 (73.64)		
General anesthesia + nerve blocking	154 (25.67)	67 (25.97)		
Nerve blocking	3 (0.50)	1 (0.39)		
Postoperative fluid intake/case (%)			0.171	0.680
< 1 000 mL	173 (28.83)	78 (30.23)		
⩾ 1 000 mL	427 (71.17)	180 (69.77)		
Postoperative analgesic pump/case (%)			0.044	0.834
Use	513 (85.50)	222 (86.05)		
No	87 (14.50)	36 (13.95)		
Time of first meal after surgery/h	18.32 ± 4.74	18.16 ± 4.79	0.452	0.651
Length of postoperative bed rest/d	12.24 ± 4.08	11.98 ± 4.07	0.857	0.392
Constipation history/case (%)			0.005	0.944
Yes	331 (55.17)	143 (55.43)		
No	269 (44.83)	115 (44.57)		
Intestinal flora/(lgCFU·g^{-1})				
Bif	7.66 ± 0.89	7.65 ± 0.85	0.153	0.879
LAB	7.89 ± 0.58	7.86 ± 0.64	0.673	0.501
EFA	6.69 ± 1.18	6.71 ± 1.16	0.229	0.819
EMB	8.21 ± 1.45	8.17 ± 1.44	0.371	0.711
NRS2002 (score)	2.66 ± 1.13	2.64 ± 1.15	0.237	0.813
Na^+/(mmol/L)	141.33 ± 2.18	141.26 ± 2.24	0.428	0.669
K^+/(mmol/L)	3.59 ± 0.27	3.62 ± 0.22	1.574	0.116
Ca^{2+}/(mmol/L)	2.39 ± 0.54	2.41 ± 0.49	0.511	0.609
Mg^{2+}/(mmol/L)	0.92 ± 0.07	0.91 ± 0.09	1.755	0.080
CRP/(mg/L)	6.38 ± 1.39	6.41 ± 1.26	0.298	0.766
HbA1c/%	8.50 ± 1.35	8.54 ± 1.28	0.404	0.686

CRP: C-reactive protein; HbAlc: glycosylated hemoglobin; Bif: *Bifidobacterium*; LAB: *Lactic acid bacteria*; EFA: *Enterococcus faecalis*; EMB: *Enterobacter*.

2.2 训练集OTLF患者PKP术后便秘的单因素分析

将训练集患者进行单因素分析，结果显示，手术时间、术后饮水量<1 000 mL、术后首次进食时间、术后卧床时间、双歧杆菌、乳酸菌、肠球菌、肠杆菌、NRS2002、钠、钾、HbA1c水平均与OTLF患者PKP术后便秘风险增加相关，P均<0.05，见表2。

表 2 训练集OTLF患者PKP术后便秘的单因素分析（n=600）

Table 2 Univariate analysis of postoperative constipation in OTLF patients undergone PKP (n = 600)

Factor	β	SE	P	OR (95% CI)
Sex	−0.169	0.172	0.327	0.845 (0.603-1.183)
Age	−0.005	0.014	0.700	0.995 (0.968-1.022)
Course of disease	0.018	0.019	0.356	1.018 (0.980-1.057)
The surgery time	0.261	0.028	< 0.001	1.299 (1.230-1.371)
Anesthesia method	0.092	0.195	0.637	1.096 (0.749-1.605)
Postoperative fluid intake < 1 000 mL	1.135	0.185	< 0.001	3.110 (2.162-4.474)
Postoperative analgesic pump	−0.193	0.247	0.435	0.825 (0.509-1.338)
Time of first meal after surgery	0.238	0.022	< 0.001	1.269 (1.215-1.371)
Postoperative bed rest	0.364	0.031	< 0.001	1.439 (1.353-1.530)
Constipation history	0.004	0.172	0.981	1.004 (0.717-1.406)
Bif	3.383	0.323	< 0.001	29.448 (15.646-55.424)
LAB	10.167	2.398	< 0.001	9.413 (7.060-52.968)
EFA	−2.066	0.174	< 0.001	0.127 (0.090-0.178)
EMB	−1.645	0.139	< 0.001	0.193 (0.147-0.254)
NRS2002	0.999	0.092	< 0.001	2.714 (2.265-3.253)
Na^+	−0.431	0.048	< 0.001	0.650 (0.592-0.714)
K^+	−8.736	0.740	< 0.001	0.214 (0.036-0.621)
Ca^{2+}	−0.073	0.116	0.530	0.930 (0.740-1.167)
Mg^{2+}	0.247	0.966	0.798	1.280 (0.193-8.500)
CRP	0.005	0.045	0.915	1.005 (0.919-1.099)
HbA1c	1.359	0.112	< 0.001	3.892 (3.126-4.846)

β: partial regression coefficient; SE: standard error; OR: odds ratio; the other abbreviations are exmplained in the note to Table 1.

2.3 LASSO回归筛选最佳的影响因素

对表2所有相关变量进行LASSO回归分析，结果显示，手术时间、术后首次进食时间、双歧杆菌、乳酸菌、肠球菌、肠杆菌、NRS2002、钠、钾、HbA1c被保留，删除变量术后饮水量及术后卧床时间。模型标准化公式为：y= −1.226+0.007×手术时间+0.004×术后首次进食时间+0.062×双歧杆菌+0.117×乳酸菌−0.041×肠球菌−0.028×肠杆菌+0.018×NRS2002+0.004×钠−0.149×钾+0.032×HbA1c。见图1、图2。

2.4 多因素logistic回归分析

将经LASSO回归分析筛选的最佳因素纳入多因素logistic回归分析，结果显示，术后首次进食时间〔比值比（odds ratio, OR）= 1.323，95%置信区间（confidence interval, CI）：1.203 ~ 1.454〕、双歧杆菌（OR= 6.454，95%CI：1.021 ~ 7.937）、乳酸菌（OR= 4.593，95%CI：2.647 ~ 8.375）、NRS2002（OR= 10.121，95%CI：1.506 ~ 28.018）、钠（OR= 0.713，95%CI：0.621 ~ 0.820）、HbA1c（OR= 3.661，95%CI：2.849 ~ 4.704）是OTLF患者PKP术后便秘的影响因素，P均< 0.05，见表3。

2.5 建立OTLF患者PKP术后便秘的列线图模型

将所得的6项影响因素建立列线图模型方程：Log（P）= 0.280×术后首次进食时间+3.596×双歧杆菌+8.085×乳酸菌+2.315×NRS2002-0.338×钠+1.298×HbA1c-33.103，各预测因子评分相加为模型总分，根据总分对应OTLF患者PKP术后便秘的风险，见图3。

2.6 列线图预测模型ROC曲线分析

ROC曲线分析结果显示，训练集中预测OTLF患者PKP

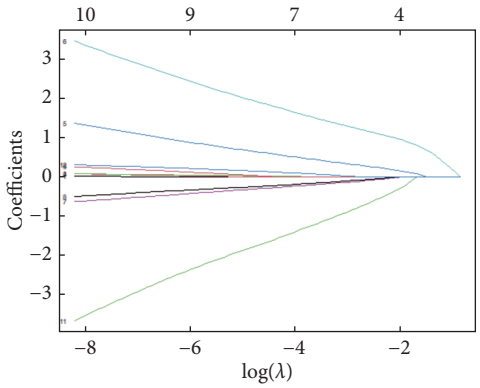

图 1 LASSO回归路系数径图

Fig 1 LASSO regression coefficient path plot

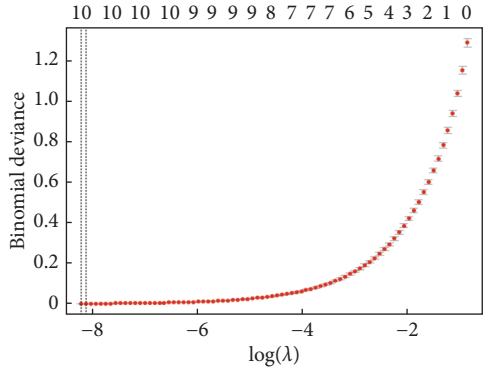

图 2 LASSO回归交叉验证图

Fig 2 LASSO regression cross-validation graph

术后便秘风险的曲线下面积(area under the curve, AUC)为0.842(95%CI: 0.793 ~ 0.892), 验证集的AUC为0.860(95%CI: 0.830 ~ 0.889), 见图4。

2.7 列线图模型校准度

校准曲线结果显示, 训练集与验证集的预测曲线与标准曲线基本拟合, Hosmer-Lemeshow检验结果显示, χ^2= 9.648、5.599, 均P> 0.05, 见图5。

2.8 列线图决策分析曲线

决策曲线分析结果显示, 该模型训练集和验证集的总损失曲线整体趋势都是随着阈值增加而下降, 表明模型在训练和验证过程中对阈值调整的响应具有一定的一致性, 见图6。

3 讨论

PKP是一种广泛应用于治疗OTLF的微创手术, 其主要目的是缓解患者疼痛, 恢复椎体高度, 改善患者生活质量[13]。然而, 术后并发症的发生会对患者的康复产生不利影响, 其中, 便秘是一个常见且不容忽视的问题。便秘不仅会增加患者痛苦, 还会导致患者腹胀, 使其食欲下降, 从而延缓整体康复进程[14]。GORLER等[15]研究指出, 便秘作为手术患者最常见的并发症, 不仅延长住院时间,

表 3　训练集的多因素logistic回归分析（*n*=600）

Table 3　Multiple factor logistic regression analysis in the training set (*n* = 600)

Factor	β	SE	Wald χ^2	OR (95% CI)	P
Intercept	−33.103	10.038	−3.298	—	< 0.001
The surgery time	0.291	0.167	1.750	1.338 (0.966-1.855)	0.080
Time of first meal after surgery	0.280	0.048	5.793	1.323 (1.203-1.454)	< 0.001
Bif	3.596	0.388	9.276	6.454 (1.021-7.937)	< 0.001
LAB	8.085	8.261	2.189	4.593 (2.647-8.375)	0.029
EFA	−2.192	1.160	−1.890	0.112 (0.012-1.084)	0.059
EMB	−1.978	1.517	−1.304	0.138 (0.007-2.706)	0.138
NRS2002	2.315	0.972	2.381	10.121 (1.506-28.018)	0.017
Na^+	−0.338	0.071	−4.758	0.713 (0.621-0.820)	< 0.001
K^+	0.475	0.720	0.660	1.608 (0.392-6.590)	0.509
HbA1c	1.298	0.128	10.146	3.661 (2.849-4.704)	< 0.001

β: partial regression coefficient; SE: standard error; OR: odds ratio; the other abbreviations are exmplained in the note to Table 1.

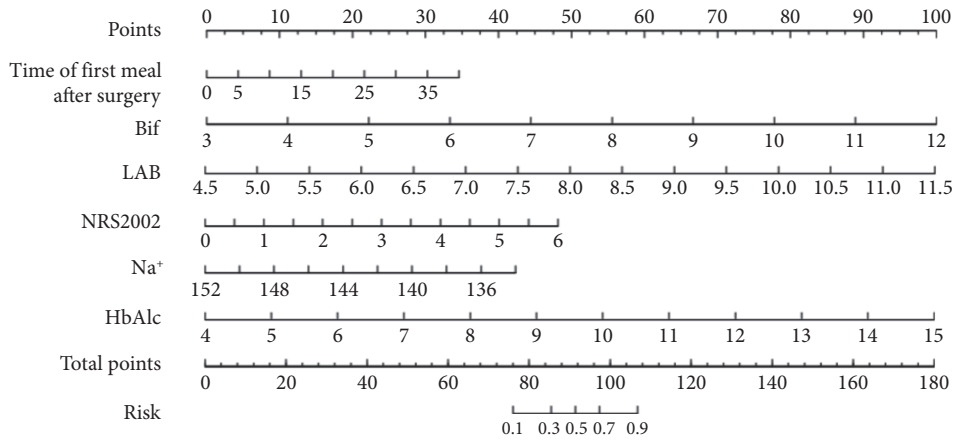

图 3 OTLF患者PKP术后便秘的列线图模型

Fig 3 Nomogram model of post-PKP constipation in OTLF patients

The abbreviaions are explained in the note to Table 1.

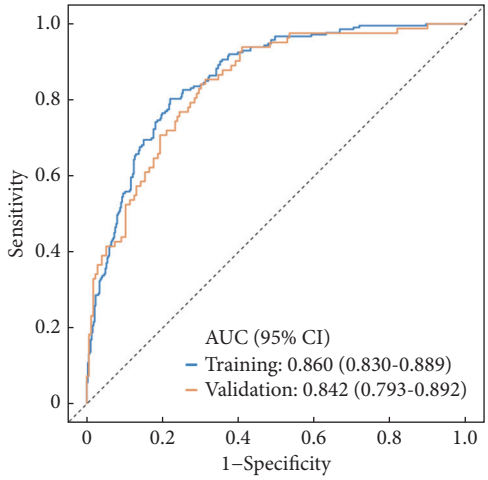

图 4 训练集与验证集中列线图预测OTLF患者PKP术后便秘的ROC曲线图

Fig 4 ROC curves of nomogram for predicting post-PKP constipation in OTLF patients in the training and validation sets

Training set (n = 600) and validation set (n = 258).

增加患者医疗费用，还会诱导肠梗阻的发生，对患者术后恢复造成不利影响。因此，构建OTLF患者PKP术后便秘的风险预测模型，对于优化围术期管理，改善患者预后具有重要意义。

本次研究发现，术后首次进食时间是OTLF患者PKP术后便秘的影响因素。分析原因为，术后首次进食时间的长短与肠道功能恢复有关。进食是刺激胃肠道活动的重要因素，延迟进食会导致肠道蠕动，使得消化液分泌延迟，进而增加便秘的发生。RAO等[16]研究表明，术后较晚进食的患者，肠道恢复较慢，术后便秘的风险越高。同时，TAO等[17]发现，术后长时间禁食容易减慢肠道蠕动，导致肠道内容物水分被过度吸收，从而增加便秘风险。肠道微生物群在调节胃肠道功能方面发挥着重要作用，但在围术期由于麻醉药物的影响可能促使肠道菌群失衡[18]。双歧杆菌与乳酸菌作为益生菌的代表，其能够

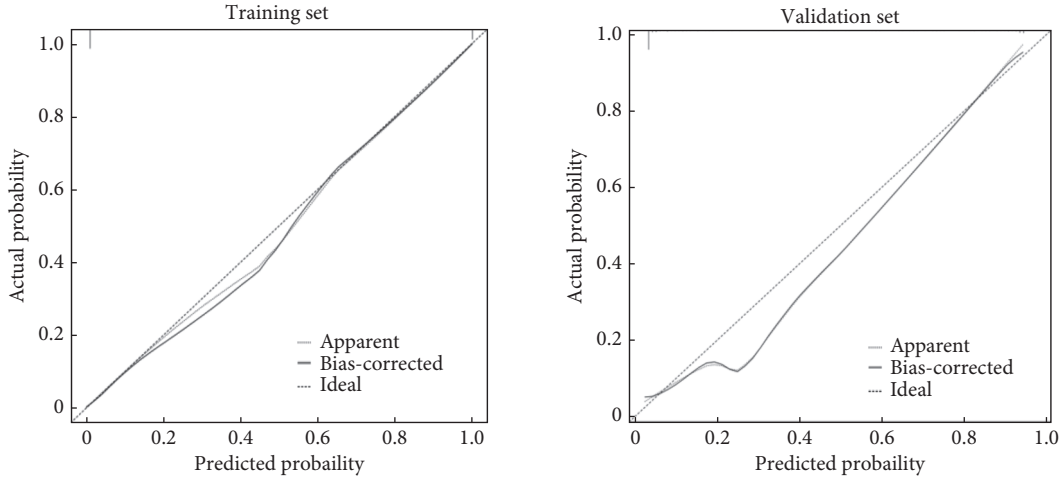

图 5 训练集与验证集中列线图预测OTLF患者PKP术后便秘的校准曲线图

Fig 5 Calibration curves of nomogram for predicting post-PKP constipation in OTLF patients in the training and validation sets

Training set (n = 600) and validation set (n = 258).

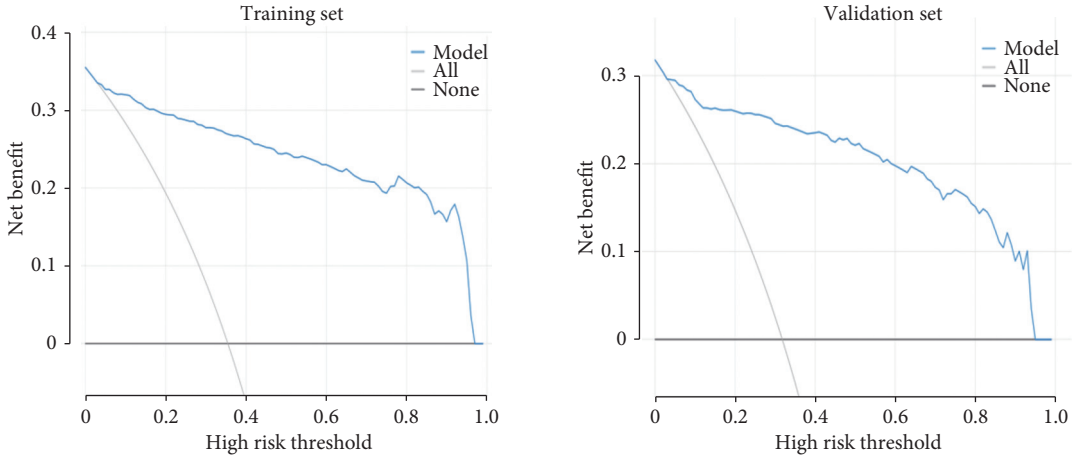

图 6 训练集与验证集中列线图预测OTLF患者PKP术后便秘的决策分析曲线图

Fig 6 Decision analysis curves of nomogram for predicting post-PKP constipation in OTLF patients in the training and validation sets

Training set (n = 600) and validation set (n = 258).

抑制有害细菌生长, 促进有益菌繁殖, 通过调节肠道菌群平衡, 保障肠道健康, 从而减少便秘的发生[19]。LAN等[20]研究指出, 双歧杆菌与乳酸菌二者均能够增强肠道免疫系统, 促进抗菌肽产生, 提升肠道对有害病原的防御能力, 帮助保持肠道健康状态, 进一步预防便秘的发生。因此, 本次研究发现, 双歧杆菌、乳酸菌是OTLF患者PKP术后便秘的影响因素(P均<0.05)。HUANG等[21]发现, 术后给予益生菌干预, 可增加机体双歧杆菌与乳酸菌水平, 从而有效地减少化学疗法诱导的胃肠道并发症, 并可增加粪便中的水分含量, 使其更加柔软, 便于排出, 进而有效避免便秘的发生。

NRS2002评分升高提示患者存在营养不良的风险[22]。本研究同样发现, NRS2002是OTLF患者PKP术后便秘的危险因素。分析原因为, 营养风险提示着患者营养素不足, 缺乏膳食纤维, 进而减少肠道内容物体积, 降低肠道蠕动力, 增加便秘风险[23]。同时, 维生素与矿物质的缺乏也容易影响肠道正常功能, 导致排便困难。因此, 本研究同样发现血钠水平低也是OTLF患者PKP术后便秘的危险因素($P<0.05$)。分析原因为, 钠是体内主要的电解质之一, 参与维持细胞外液的渗透压与体液平衡。低钠血症与水分滞留和细胞外液量增加相关[24]。钠离子是肠道吸收水分的关键因素之一, 当机体血钠水平降低时, 肾脏会通过调节水分的重吸收, 以维持体内水电解质平衡, 使肠道内容物水分减少, 从而导致粪便干硬, 增加便秘的发生风险。DOMINGUEZ RIEG等[25]认为, 低钠血症容易导致肠道平滑肌活动异常, 从而影响肠道正常蠕动, 使其蠕动减缓, 导致食物在肠道内停留时间过长, 水分被过度吸收, 使得粪便变干, 排便困难, 进一步加剧便秘。本研究还发现, HbA1c是OTLF患者PKP术后便秘的影响因素($P<0.05$)。分析原因为, HbA1c是血红蛋白与血清中糖类物质结合形成的产物, 其能够反映患者近3月的平均血糖水平。然而, 患者当血糖控制不理想时, 过高浓度的葡萄糖会通过渗透作用促使体内多余水分排出, 使粪便缺乏足够水分进行软化[26]。此外, 长期高血糖状态可能损伤自主神经功能, 引发肠道自主神经调节异常, 导致胃肠道蠕动能力下降, 最终诱发便秘[27]。并在QUAST等[28]研究中得到证实。

综上所述, 术后首次进食时间、双歧杆菌、乳酸菌、NRS2002、钠、HbA1c水平是OTLF患者PKP术后便秘的影响因素, 通过上述因素本研究初步构建了一个列线图模型发现具有一定效能。然而, 本次所有数据均来自单一中心, 可能存在选择偏倚, 未来需通过多中心大样本研究进一步验证模型的普适性, 并评估术后便秘的长期影响, 延长随访时间, 以完善模型预测范围。

*　　*　　*

作者贡献声明　刘孝丰负责论文构思、数据审编、正式分析、初稿写作和审读与编辑写作, 吴艳华与蔡子鸣负责数据审编和审读与编辑写作, 康麟与林淑惠负责论文构思、研究方法和经费获取, 林文平负责监督指导和审读与编辑写作。所有作者已经同意将文章提交给本刊, 且对将要发表的版本进行最终定稿, 并同意对工作的所有方面负责。

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利益冲突　所有作者均声明无利益冲突

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