BMC Surgery

RESEARCH Open Access

Geriatric nutritional risk index as a predictor of major postoperative complications in emergency femoral hernia patients

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Abstract

Background To evaluate the prognostic values of GNRI for major postoperative complications in emergency femoral hernia patients.

Methods In this cross-sectional study, we enrolled 105 emergency femoral hernia patients. GNRI was calculated using preoperative body weight, height, and serum albumin. The primary outcome was a composite of major postoperative complications. Univariable and multivariable logistic regression analyses were used to examine the association between GNRI and major complications. The ability of GNRI in detecting major complications was assessed by area under the curve (AUC).

Results The prevalence of low, moderate, and severe nutritional risk was 18.1%, 25.7%, and 10.5%. Five patients (4.8%) had major postoperative complications. Higher GNRI was associated with lower risk of major complications after adjusting for age and sex (aOR = 0.90, 95% CI: 0.81-1.00, $P = 0.044$). The AUC for GNRI identifying major complications was 0.812 (95% CI: 0.640–0.984, $P = 0.019$), and the optimal cut-point value was 90.96 (sensitivity: 80.0%; specificity: 72.0%).

Conclusions GNRI is significantly associated with major postoperative complications. It is a simple and useful prognostic tool for femoral hernia patients in emergency settings.

Keywords Emergency, Femoral hernia, Geriatric nutritional risk index, Postoperative complications

Background

Emergency groin hernia remains a potentially fatal surgical challenge [1]. Postoperative complication and mortality rates remain high after emergency groin hernia repair [2]. Femoral hernias account for 2–4% of all groin hernias, which had markedly higher risk for emergency repairs in women and elderly patients [3]. It was also associated with a higher risk of laparotomy and bowel resection, and consequently, a higher risk of postoperative complications and mortality [1, 4]. A recent systematic review showed that the 30-day mortality rate for emergency femoral hernia ranged from 2.9–14.3%.[1] Another registry study showed that overall morbidity was 21%, and major complication rate was 5% after emergency hernia repair in elderly, which was much higher when compared to elective suirgery [4].

Malnutrition or undernutrition is highly prevalent condition in older adults [5]. There are evidences indicated that preoperative nutrition status is associated with

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postoperative outcomes, and malnutrition increased risk of adverse clinical outcomes such as complications and mortality [6, 7]. The Geriatric Nutritional Risk Index (GNRI) is a nutrition-related risk assessment tool, which is calculated using height, body weight, and serum albumin, and has been used in various clinical settings [8, 9]. It is a simple and accurate tool for predicting the risk of morbidity and mortality in hospitalized elderly patients [8]. In recent years, many studies have demonstrated the value of GNRI in the prognosis of cancer patients such as gallbladder cancer, gastric cancer, and cervical cancer [10–12]. GNRI has also been used for nutrition assessment and predicting outcomes in patients received general surgery. In a prospective multicenter cohort study including 366 patients who underwent abdominal surgery, patients in the low GNRI group had a significantly higher rate of postoperative complications and longer length of hospital stay [13].

GNRI could be calculated easily using routine blood examination in the emergency setting. Thus, we thought it was a suitable nutrition assessment tool for emergency femoral hernia patients, and might have a predicting value for postoperative complications. However, due to the low incidence of femoral hernia, study on the value of GNRI on predicting postoperative complication in patients with femoral hernias is scant. In this study, we aimed to evaluate the nutritional status in emergency femoral hernia patients by using the preoperative GNRI, and to investigated its prognostic values for major postoperative complications in a large hernia center.

Methods

Study design and participants

This is a cross-sectional study. Femoral hernia patients who were admitted to Beijing Chaoyang Hospital, Capital Medical University through emergency department from January 1, 2015 to December 31, 2021 were included. The inclusion criteria were emergency femoral hernia patients who underwent hernia repair surgery in the Department of Hernia and Abdominal Wall Surgery. Patients with no information for body weight, height, preoperative value of serum albumin, and age < 50 years were excluded. This study was approved by the institutional review board of Beijing Chaoyang Hospital. The written informed consent was waived because only retrospective data was used in this study.

Data collection

The demographic and clinical data of the patients were collected from electronic medical records, including age, sex, body weight, height, comorbidities (hypertension and diabetes mellitus), surgical methods (open or laparoscopic surgery), hernia content ischemia/necrosis, hernia content resection, intensive care unit (ICU) admission, duration of operation, and hospital stays. Preoperative serum albumin value was extracted from blood biochemistry test in the laboratory data. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m). The GNRI was calculated as: GNRI = [1.489 × albumin (g/L)] + [41.7 × (weight/ideal weight)] [8]. The ideal weight was calculated from the Lorentz formula: for men = H − 100 − [(H − 150)/4], for women = H − 100 − [(H − 150)/2.5]. We set weight/ideal weight = 1 when weight exceeded ideal weight. Four grades of nutrition-related risk were defined according to GNRI values: major risk (GNRI: <82), moderate risk (GNRI: 82 to ≤92), low risk (GNRI: 92 to ≤98), and no risk (GNRI: >98) [8].

Outcome measures

The primary outcome was a composite of major postoperative complications including organ failure, acute diseases of respiratory and circulatory systems, other severe complications which needed intervention or treatment and in-hospital mortality. Major postoperative complications were identified from discharge diagnoses in the electronic medical records. Pre-existing diseases, symptoms and sighs before surgery were not considered as postoperative complications.

Statistical analysis

Continuous variables were presented as mean ± standard deviation or median (interquartile range), and categorical variables were presented as frequency and percentage. Differences between patients with and without nutrition-related risk were assessed using χ^2 test for categorical factors and one way analysis of variance for continuous factors. Univariable and multivariable logistic regression analyses were used to examine the association between GNRI and major complications. Age, sex and variables which were significantly associated with major complication in the univariable analysis were included in the multivariable analysis. The receiver operator characteristic curves (ROC) were used to identify the cut point of GNRI with maximum sensitivity and specificity (Youden Index), and the area under the curve (AUC) was used to assess overall discriminating power. The value of AUC ranges from 0 to 1, with 0.7 or higher indicating a strong discriminating power. Two-sided p value < 0.05 was considered as statistically significant. All analysis were performed using SPSS 19.0.

Results

A total of 119 femoral hernia patients were admitted through emergency department and underwent hernia repair surgery from January 1, 2015 to December 31, 2021. After excluding 7 patients without information of body weight or height, 6 patients without information of preoperative serum albumin, and one patient age < 50

Table 1 Baseline characteristics of patients according to GNRI status

	All ($n=105$)(%)	GNRI > 98($n=48$)(%)	GNRI ≤ 98($n=57$)(%)	χ^2/F	*P* value
Age (years)	75.78 ± 10.93	**73.13 ± 10.45**	**78.02 ± 10.92**	**5.440**	**0.022**
BMI (kg/m^2)	21.01 ± 3.15	**22.01 ± 2.75**	**20.17 ± 3.24**	**9.725**	**0.002**
Sex				0.978	0.323
Male	29(27.6)	11(22.9)	18(31.6)		
Female	76(72.4)	37(77.1)	39(68.4)		
Diabetes				< 0.001	1.000
No	95(90.5)	43(89.6)	52(91.2)		
Yes	10(9.5)	5(10.4)	5(8.8)		
Hypertension				0.066	0.798
No	67(63.8)	30(62.5)	37(64.9)		
Yes	38(36.2)	18(37.5)	20(35.1)		
Surgical method				3.487	0.062
Laparoscopic	26(24.8)	16(33.3)	10(17.5)		
Open	79(75.2)	32(66.7)	47(82.5)		
Ischemia/necrosis				0.126	0.723
No	77(73.3)	36(75.0)	41(71.9)		
Yes	28(26.7)	12(25.0)	16(28.1)		
Resection				0.029	0.864
No	89(84.8)	41(85.4)	48(84.2)		
Yes	16(15.2)	7(14.6)	9(15.8)		
ICU admission				2.537	0.111
No	97(92.4)	47(97.9)	50(87.7)		
Yes	8(7.6)	1(2.1)	7(12.3)		
Major complications				2.698	0.100
No	100(95.2)	48(100.0)	52(91.2)		
Yes	5(4.8)	0(0)	5(8.8)		
Serum albumin (g/l)	37.98 ± 5.74	**41.94 ± 2.54**	**34.64 ± 5.57**	**70.302**	**< 0.001**
Hospital stays (d)	5.77 ± 4.38	**4.77 ± 2.85**	**6.61 ± 5.22**	**4.784**	**0.031**

GNRI: geriatric nutritional risk index; BMI: body mass index; ICU: intensive care unit

Table 2 Major complications stratified by GNRI classes

GNRI	All	Major complications, *n*(%)	Specific complications			
			Atrial fibrillation and flutter	Acute gastrointestinal hemorrhage	Acidosis	Death*
> 98	48	0(0)	0	0	0	0
92 to ≤ 98	19	1(5.3)	1	0	0	0
82 to ≤ 92	27	2(7.4)	1	0	0	1
< 82	11	2(18.2)	0	1	1	0
Total	105	5(4.8)	2	1	1	1

GNRI: geriatric nutritional risk index. *Death due to multiple organ failure

years, 105 patients were included in the final analysis. The mean age of all patients was 75.78 ± 10.93 years and 76 (72.4%) were women. The mean BMI was 21.01 ± 3.15 kg/m^2. Of all patients, 10 (9.5%) and 38 (36.2%) had diabetes and hypertension, 79 (75.2%) patients underwent open hernia repair surgery, 28 (26.7%) had hernia contents ischemia or necrosis, 16 (15.2%) underwent hernia contents resection, and 8 (7.6%) were transferred to ICU after surgery. The mean hospital stay was 5.77 ± 4.38 days.

The mean of GNRI value was 94.65 ± 9.21, with a range of 65.99 to 112.43. The prevalence of no, low, moderate, and severe nutritional risk were 45.7%, 18.1%, 25.7%, and 10.5%, respectively. Compared to patients with no nutritional risk, those with nutritional risk were significantly older, had lower BMI and serum albumin, and longer hospital stay (Table 1).

Five patients (4.8%) had major postoperative complications, including two atrial fibrillation and flutter, one acute gastrointestinal hemorrhage, one acidosis, and one patient died from multiple organ failure. The mean GNRI value of patients with major complications were significantly lower than that of patients without major complications (83.71 ± 11.35 vs. 95.20 ± 8.80, $p=0.006$). All five patients with major complications had certain degree of nutritional risk, with one had low risk, two had moderate risk, and two had severe nutritional risk (Table 2).

Univariable analysis showed that age and GNRI was associated with major complications, with an 11% reduction in the risk of major complications for every 1-point increase in GNRI (OR=0.89, 0.82–0.98, p=0.014). Sex, BMI, diabetes, hypertension, surgical methods, hernia contents ischemia or necrosis, resection were not associated with major complications in the univariable analysis. Multivariable analysis showed that after adjusting for age and sex, every 1-point increase in GNRI was associated with a 10% reduction in the risk of major complications (OR=0.90, 0.81-1.00, p=0.044).

GNRI had an AUC of 0.812 (95%CI: 0.640–0.984) as a predictor of major complications. The optimum cutoff value was 90.96, with a sensitivity of 80.0% and specificity of 72.0%. The AUC for serum albumin as a discriminator of major complications was 0.798 (p=0.025) and for BMI was 0.474 (p=0.843, Table 3).

Discussion

In the present study, we used GNRI, a simple nutritional risk assessment tool calculated by body weight, height and preoperative albumin levels, for nutritional risk assessment in emergency femoral hernia patients, and found that 54.3% had certain degree of nutritional risk, and 10.5% had severe nutritional risk. Multivariable analysis showed that higher GNRI was associated with lower risk of major complications after adjusting for age and sex. In the ROC analysis, the AUC for GNRI identifying major complications was 0.812, with an optimal cut-point value of 90.96. These results indicated that malnutrition was common in emergency femoral hernia patients, and GNRI could be useful in nutritional risk assessment in emergency settings and a potential predictor for postoperative major complications.

Malnutrition is a highly prevalent condition and associated with an increased risk of adverse clinical outcomes in older adults [5]. The prevalence of malnutrition in older adults varies considerably due to different assessment tools and study population [5]. It was reported that 16-78% of older inpatients were malnourished or at risk of malnutrition [14]. Many previous studies have used GNRI to assess the nutritional status of elderly patients [15, 16]. Liu et al. conducted a multicenter retrospective study on 854 older adult cancer patients in 34 hospitals and found the prevalence of malnutrition was 42.7%, including 36.7% with moderate malnutrition and 6.1% with severe malnutrition [15]. Zhao et al. conducted a cross-sectional study on 740 older hospitalized patients, with 51.8% of patients had nutritional risk and 6.4% had major risk [16].

In this study, we used GNRI for nutritional risk assessment in older femoral hernia patients, and found that more than half of patients had certain degree of nutritional risk, and one in ten patients had severe nutritional risk. The prevalence of nutritional risk found in this study was higher than that reported by Liu et al. in older adult cancer patients [15], and the prevalence of severe nutritional risk was higher than that among older hospitalized patients reported by Zhao et al. [16]. We thought that this difference might be due to the different populations studied. In this study, we included emergency femoral hernia patients, who were more likely to have acute life-threatening complications, and a subsequently higher level of nutritional risk [16]. In addition, the most common symptoms among emergency femoral hernia patients included pain, nausea, vomiting, and bowel obstruction caused by incarceration or strangulation [17–19]. These symptoms might present for several days before patients came to emergency department for medical service, and put patients at risk of malnutrition due to inadequate food intake and compromise of gastrointestinal function [5, 20]. Therefore, our results suggested that emergency femoral hernia patients carried higher risk for malnutrition and their nutritional status should be evaluated preoperatively. Nutritional risk assessment and awareness on malnutrition among these patients is crucial to provide care [14].

A variety of nutrition screening and assessment tools are currently used in clinical setting, such as the subjective global assessment (SGA) [21], the mini nutritional assessment (MNA) [22], the nutritional risk screening (NRS 2002) [23], and the Global Leadership Initiative on Malnutrition (GLIM) criteria for the diagnosis of malnutrition [24]. These tools are considered as effective for nutrition assessment and adverse outcomes prediction in adult patients [25]. However, most of these tools are time-consuming, which need to be combined with subjective evaluation indicators and require high level of patient cooperation, such as questions for weight loss and dietary intake [9, 16]. Although these tools might be used in general practice, hospital admission, and nursing home, they were not suitable for patients requiring

Table 3 ROC analysis for GNRI, BMI, and serum albumin

	AUC	*P* value	cOR	*P* value	aOR*	*P* value
GNRI	**0.812**	**0.019**	**0.89 (0.82–0.98)**	**0.014**	**0.90(0.81-1.00)**	**0.044**
Serum albumin	**0.798**	**0.025**	**0.85(0.75–0.96)**	**0.011**	**0.86(0.75–0.99)**	**0.040**
BMI	0.474	0.843	1.11(0.86–1.43)	0.418	1.16(0.90–1.49)	0.256

ROC: receiver operating characteristic curve; GNRI: geriatric nutritional risk index; BMI: body mass index; AUC: area under the curve; cOR: crude odds ratio; aOR: adjusted odds ratio. *Adjusted for age and sex

emergency surgery [25]. Therefore, more easily applicable and time-saving tools are needed in emergency settings [16].

The GNRI was initially proposed to predict nutrition-related complications in hospitalized elderly patients, and was calculated using height, body weight, and serum albumin [9]. These objective parameters could be obtained by simple physical and biochemical examination, which is routine examination for emergency patients. Its simplicity could help in reducing the time spent on the nutrition assessment process [14]. Due to its simplicity, GNRI is widely used in preoperative nutritional status assessment, and it was validated to have potential to identify patients at elevated risk for postoperative adverse outcomes such as arrhythmia, pulmonary infection, acute kidney injury, and prolonged hospital stays after spine, cardiac, and major abdominal surgeries [26–28]. Previous study has demonstrated the usefulness of GNRI in emergency setting, and it was recognized as an independent factor associated with systemic organ dysfunction in older patients who presented with cholecystitis to the emergency department [29]. In this study, we found that higher GNRI was associated with lower risk of major complications. This finding corroborated prior study that demonstrated an inverse association between GNRI values and prevalence of complications [9]. The ROC analysis showed that the optimum cutoff value was 90.96, with an AUC of 0.812. This result suggested that moderate or major nutritional risk according to GNRI were associated with higher risk of postoperative major complications.

In the present study, we also analyzed the predictive value of BMI and serum albumin alone, and the results showed that preoperative serum albumin was associated with major complications. Serum albumin is produced by the liver and was considered as an important nutritional marker of the body [30]. Previous study has demonstrated that preoperative hypoalbuminemia significantly increased the risk for major complications in hip fracture patients [7]. However, use of serum albumin as a biomarker to identify malnutrition in older adults should be discouraged, since serum albumin is easily influenced by systemic inflammation, hydration status, and acute disease [5, 31]. GNRI can assess both serum albumin and BMI in the meantime [10]. Our study demonstrated that GNRI had a higher AUC value of 0.812 than serum albumin and BMI, which suggested that GNRI had higher predictive value for major complications than that of serum albumin or BMI alone.

For malnourished patients or those at risk of malnutrition, perioperative nutritional support may reduce postoperative complications and improve outcomes [32]. It was recommended that patients who were candidate for surgery should be evaluated for nutritional status and those at risk should postpone the elective surgery and receive proper nutritional support [7, 32]. However, emergency femoral hernia patients should be repaired as soon as possible, because the delayed treatment might increase risk of complications and mortality [18, 33]. Therefore, there might not be an adequate time to correct preoperative malnutrition for emergency femoral hernia patients. How to improve preoperative nutrition of emergency femoral hernia patients is challenging. In clinical practice, malnutrition should be addressed as soon as possible postoperatively for emergency cases, and careful postoperative follow-up and nutrition support should be conducted accordingly to improve patient outcomes [7, 10]. In some cases, nutritional monitoring and therapy might be required even after discharge from the hospital [34].

To the best of our knowledge, this is the first study to use GNRI for preoperative nutritional risk assessment in emergency femoral hernia patients. However, this study had some limitations. Firstly, this was a small single-center study. Therefore, our study had a risk for being underpowered in detecting true differences, and the results might not be representative for all femoral hernia patients. In this study, there was no significant correlation between factors such as BMI, diabetes, ischemic or necrotic hernia content, and bowel resection with major complications in the univariable analysis, which might be different from other studies [17, 18]. These results should be interpreted with caution because the discrepancy may be attributable to the relatively small sample size in this study. Future studies should expand sample size to achieve larger power and provide more reliable evidence. Secondly, since height and weight were needed to calculate BMI and GNRI, patients without available data on these two indicators were excluded from this study. However, these patients were more likely to be bedridden and cannot cooperate with the measurement of height and weight. Thus, this may introduce a selection bias by excluding these patients because these patients were more likely to have poor nutritional status.

Conclusions

GNRI was a simple and useful preoperative nutritional risk assessment tool in emergency femoral hernia patients. GNRI is significantly associated with major postoperative complications, and a potential prognostic tool for emergency femoral hernia patients.

Acknowledgements
Not applicable.

Author contributions
QM designed the study, analyzed the data, interpreted the results, and drafted the manuscript. XL, CL, HY, JC searched the literature, collected the data and revised the manuscript. YS conceived the study, designed the study, supervised the study, interpreted the results, and revised the manuscript.

All authors contributed to the manuscript and read and approved the final version of the manuscript.

Funding
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability
The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the institutional review board of Beijing Chaoyang Hospital. The written informed consent was waived because only retrospective data was used in this study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 29 August 2024 / Accepted: 12 December 2024
Published online: 23 December 2024

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