



## Case Series

## 5-mFI is more accurate than ASA score in predicting postoperative mortality in rectal cancer: A case series of 109 patients

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## ABSTRACT

**Introduction:** The aim of this study was to compare the accuracy of 5-mFI (modified frailty index) to ASA score (American Society of Anesthesiologists score) in predicting postoperative mortality in patients with rectal cancer.

**Materials and methods:** The ability of each parameter to predict postoperative mortality was attested in 2 ways: Area under the curve (AUC) was determined using ROC curves analysis. A comparison of AUC was performed using Delong test and Henley-McNeil test. Multivariate analysis to determine the weight of each variable in predicting postoperative mortality.

**Results:** The records of 109 patients undergoing surgical resection, for curative intent, for rectal cancer, were analyzed. Nine patients died during the 30-day postoperative period (8.25%). The optimum cutoff for 5-mFI to predict mortality using the ROC analysis was 1.5. The AUC at the cut-off point was 0.93. The optimum cutoff for ASA score to predict mortality was 1.5 and the AUC at the cut-off point was 0.81. The AUC of 5-mFI was significantly higher than the AUC of ASA score ( $p < 0.0001$  using Delong test and  $p = 0.0024$  using Hanley and McNeil test).

On univariate analysis, predictive factors of mortality were: age ( $p = 0.002$ ), ASA score  $\geq 2$  ( $p = 0.0001$ ) and 5-mFI  $\geq 2$  ( $p = 0.0001$ ). On multivariate analysis, 5-mFI  $\geq 2$  was the only factor significantly associated with increased odds of postoperative mortality (OR = 1.73; 95% CI 1.05–2.01).

**Conclusion:** 5-mFI was more accurate than ASA score in predicting postoperative mortality in patients with rectal cancer.

## 1. Introduction

Rectal cancer is a major cause of morbidity and mortality in the elderly population. The number of cases in elderly people is expected to increase as the population ages [1]. Various population-based studies show that the survival of elderly rectal cancer patients is worse compared with younger patients [2].

The geriatric rectal cancer population is a very heterogeneous group, including patients with excellent health status and others with comorbid conditions, functional dependency, and limited life expectancy [3]. In front of such heterogeneity, and complexity of surgical procedures, preoperative risks should be correctly assessed to inform clinicians of the

patient's ability to tolerate surgical resection, and thus to improve patient outcomes. With the aim of identifying high-risk surgical candidates, several preoperative risk prediction models have been proposed, the most used score is the American Society of Anesthesiologists score (ASA score) [4]. More recently, Frailty was proposed as a method used to study outcomes in surgery. One of the most widely used frailty assessment tools is the frailty index from the Canadian Study on Health and Aging (CSHA) [5,6]. In 2013, Velanovich described a simplified edition of the CSHA frailty index, which was named the Modified Frailty Index (11-mFI). The 11-mFI was created by mapping the variables in the American College of Surgeons National Surgical Quality Improvement Project (NSQIP) database used to calculate the CSHA score [5,7].

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Recently, a five-item modified frailty index (5-mFI) has been developed. The 5-mFI has been validated and shown to have a significant agreement with the 11-mFI in the context of upper gastrointestinal and multiorgan resections [8,9].

Few studies have been done to evaluate the role of 5-mFI for preoperative risk assessment of patients with rectal cancer. Therefore, the aims of this study were to determine if the 5-mFI was associated with postoperative mortality in patients undergoing rectal resections for rectal cancer and to compare the accuracy of 5-mFI to ASA score in predicting postoperative mortality after rectal resections.

## 2. Materials and methods

We reviewed the files of all consecutive adult patients undergoing surgical resection, for curative intent, for rectal cancer, between January 2013 and December 2019, in our department.

Patients aged 18 years and above who underwent partial mesorectal excision (PME) or total mesorectal excision (TME) with the construction of a colorectal or coloanal anastomosis were eligible for inclusion. All tumor stages were considered in the study. Patients who underwent abdominoperineal amputation were also included. Patients who underwent an emergency procedure, patients who underwent surgery for an indication other than adenocarcinoma, and patients who underwent palliative surgery without rectal resection were excluded from the study.

Postoperative outcomes assessed included only 30-day postoperative mortality.

### 2.1. Modified frailty index calculation

The mFI consists of 5 NSQIP preoperative variables. One point was allotted for each of the following preoperative comorbidities: congestive heart failure, chronic obstructive pulmonary disease, hypertension requiring medication, diabetes, and non-independent functional status. Possible mFI values range from 0 to 5.

### 2.2. Statistical analysis

Categorical variables were expressed as frequencies (n) with percentages, and continuous variables were expressed as medians with interquartile (IQR). The Normality of continuous data was measured by the Kolmogorov-Smirnov tests. Univariable analysis was performed by the chi square and Mann-Whitney U tests for categorical and continuous variables respectively. A backward stepwise multivariable logistic regression analysis was used to identify risk factors for mortality. Factors that were significant on univariable analysis ( $p < 0.05$ ) were included in the multivariable model. Results from multivariable analysis were reported as odds ratios (OR), 95% confidence interval (95% CI), and p value. Receiver operator characteristic curves (ROC) and an area under the curve (AUC) were generated to measure accuracy of mFI and ASA score in predicting mortality. A Comparison of AUC of mFI and ASA score was performed using both Delong test [10] and Henley-McNeil test [11]. Statistical analysis was performed using SPSS version 20 (IBM) and MedCalc statistical software. Two-tailed p values of less than 0.05 were deemed statistically significant.

The work has been reported in line with the PROCESS criteria [12].

## 3. Results

The characteristics of the 109 patients undergoing elective rectal resection for rectal cancer are presented in Table 1.

According to the American Society of Anesthesiologists score (ASA score), 70 patients were ASA 1 (64.22%), 36 patients were ASA 2 (33.02%) and 3 patients were ASA 3 (2.75%).

53% of patients had 5-mFI = 0, 18% had 5-mFI = 1, 18% had 5-mFI = 2, 9% had 5-mFI = 3 and 2% had 5-mFI = 4.

The rate of overall postoperative morbidity was 49.5%. The

**Table 1**

Patient and surgical characteristics and postoperative course of the population.

	Total patients (n = 109)	Percentage
Age: median/extremes (years)	62 [25–95]	–
Gender (Male/Female)	73/26	–
ASA score		
ASA 1	70	64.22%
ASA 2	36	33.02%
ASA 3	3	2.75%
5-mFI		
5-mFI = 0	57	53%
5-mFI = 1	20	18%
5-mFI = 2	20	18%
5-mFI = 3	10	9%
5-mFI = 4	2	2%
BMI: median/extremes (Kg/m <sup>2</sup> )	25.7 [20–34]	–
Tumor location at endoscopy		
High rectal tumor	29	26.6%
Medial rectal tumor	45	41.28%
Low rectal tumor	35	32.12%
Preoperative radiotherapy/chemo-radiotherapy	45	41.28%
Type of procedure		
Proctectomy with anastomosis	83	76.14%
Abdomino-perineal resection	26	23.86%
Type of anastomosis		
Colorectal	52/83	62.65%
Coloanal	31/83	37.35%
Construction of anastomosis		
Manual	45/83	54.21%
Stapler	38/83	45.79%
Operative complications	45	41.3%
Bleeding	30	27.5%
Rectal perforation	13	12%
Bladder perforation	2	1.8%
Enterostomy	97	89%
Permanent colostomy	26	23.85%
Diverting ileostomy	71	65.15%
Postoperative global morbidity	54	49.5%
Anastomotic leak	20	18.8%
Surgical site infection	28	25.7%
Postoperative mortality	9	8.25%

Abbreviations: ASA score: American Society of Anesthesiologists score; 5-mFI: modified frailty index; BMI: body mass index.

anastomotic leak (AL) rate was 18.8%. The surgical site infection (SSI) rate was 25.7%.

Nine patients died during the 30-day postoperative period (8.25%).

The causes of death were: pulmonary infection for five patients, massive pulmonary embolism for two patients, and AL with generalized peritonitis and septic shock for two patients.

The optimum cutoff for 5-mFI to predict mortality using the ROC analysis was 1.5. The sensitivity and specificity at the cutoff point were 100 and 78%, respectively. The AUC at the cut-off point was 0.93 (Fig. 1).

The optimum cutoff for ASA score to predict mortality was 1.5. Sensitivity at the cut-off point was 100%, specificity was 60%, and the AUC at the cut-off point was 0.81 (Fig. 1).

The AUC of 5-mFI was significantly higher than the AUC of ASA score (0.93 vs. 0.81;  $p < 0.0001$  using Delong test and  $p = 0.0024$  using Hanley and McNeil test).

In order to determine predictive factors of mortality, study population was divided in 2 groups: group A (no death: 100 patients) was compared to group B (death: 9 patients).

On univariate analysis (Table 2), predictive factors of mortality were: age ( $p = 0.002$ ), ASA score  $\geq 2$  ( $p = 0.0001$ ) and 5-mFI  $\geq 2$  ( $p = 0.0001$ ).

On multivariate analysis (Table 2), 5-mFI  $\geq 2$  was the only factor significantly associated with increased odds of postoperative mortality (OR = 1.73; 95% CI 1.05–2.01).

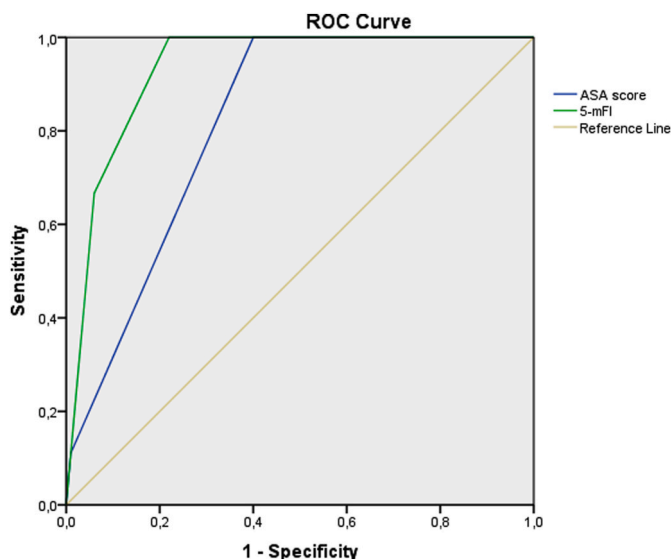


Fig. 1. ROC curve of ASA score and 5-mFI in predicting postoperative mortality in patients with rectal cancer.

Table 2  
Predictive factors of mortality in univariate and multivariate analysis.

Factor	Death: yes (n = 9)	Death: no (n = 100)	P univariate	P multivariate	OR
Male gender	55.55%	68%	0.44	-	-
Age (years)	76.78 [62–95]	59.95 [25–92]	0.002 <sup>a</sup>	Ns	-
BMI (Kg/m <sup>2</sup> )	25.43 [22–34]	26.15 [20–33]	0.13 <sup>a</sup>	-	-
ASA score ≥ 2	100%	40%	0.0001	Ns	-
5-mFI ≥ 2	100%	22%	0.0001	0.034	1.73
Low rectal tumor	33.33%	34%	0.96	-	-
Tumor size (cm)	6.38 [3–16]	5.75 [1–11]	0.71 <sup>a</sup>	-	-
APR	33.33%	25%	0.45	-	-
AL	22.22%	18%	1	-	-
SSI	22.22%	26%	1	-	-

Abbreviations: OR: odds ratio, Ns: not significant, BMI: body mass index, ASA score: American Society of Anesthesiologists score; 5-mFI: modified frailty index, APR: abdomino-perineal resection, AL: anastomotic leak, SSI: surgical site infection.

<sup>a</sup> Mann-Whitney U test.

#### 4. Discussion

We showed in the current study, that 5-mFI score was more accurate than ASA score in predicting mortality after elective rectal surgery. First, as it had the best discriminative power in predicting mortality according to the ROC curves (the best AUC). Second as it was the only independent predictive factor of mortality in multivariate analysis (OR = 1.73).

As shown in a previous study, the number of old people in our society is increasing and so is the number of elderly people with colorectal cancer [1]. The exact reasons are unknown, but theories of cancer development in the elderly are applicable to colorectal cancer [13,14]. The geriatric colorectal population is a very heterogeneous group, including patients with excellent health status and others with comorbid conditions, functional dependency, and limited life expectancy [3]. So patient frailty is becoming increasingly recognized as an important predictor of surgical outcomes [15]. The impact of the frailty index has been studied in various surgical specialties such as orthopedic [16], thoracic [17], urological [18], vascular [19], and colorectal surgeries

[10] to determine the risk of postoperative mortality and morbidity. To assess frailty, various frailty predictive models were developed. The CSHA-FI (introduced by the Canadian Study of Health and Aging) recognizes 70 potential deficits that are easily identifiable during a patient’s preoperative assessment [5,6]. In 2013, a modified frailty index (mFI) was derived by matching the CSHA-FI to 11 variables collected by the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) [5,7]. Recently, a five-item modified frailty index (5-mFI) has been developed. The 5-mFI has been validated and shown to have a significant agreement with the 11-mFI in the context of upper gastrointestinal and multiorgan resections [8,9].

The 5-mFI is judged as both reliable and feasible to use in colorectal surgery with distinct clinical advantages over alternative models [15]. For example, the popular American Society of Anesthesiology (ASA) score is determined by a subjective estimate of organ system disease and the likelihood of survival [20].

Although, some previous studies showed a significant correlation between ASA score and post-operative mortality in colorectal surgery patients [3], more recent studies found that mFI was more accurate than ASA score in predicting mortality [21]. Obeid et al. [22] identified the mFI to be a significant predictor of mortality in patients undergoing colectomies, with an OR that exceeded ASA classification (mFI, OR 14.4) vs (ASA class 4, OR 3.2) vs (ASA class 5, OR 7.1). Makary et al. [4] not only found frailty to be predictive of postoperative complications but also found frailty to significantly improve the predictive power of the ASA classification.

The originality of our study is that we performed a direct comparison between 5-mFI and ASA score in predicting mortality in patients undergoing rectal cancer surgeries (a real face-to-face comparison), by comparing the AUC of the parameters using both Delong and Hanley-McNeil tests. The difference was statistically significant in favor of 5-mFI. Moreover, 5-mFI (and not ASA score), was the only predictive factor of mortality in multivariate analysis.

Unlike previous studies, we included in the current study, only rectal cancer surgeries which involve more complex procedures than colon surgeries.

The main limitations of this study are the retrospective nature of the study and the small number of patients. Even though the sample size of this study was relatively small, and doesn’t allow to recommend the use of 5-mFI score instead of ASA score for preoperative evaluation of patients with rectal cancer, this study demonstrated, by two different statistical methods, the superiority of 5-mFI compared with ASA score in predicting postoperative mortality in patients with rectal cancer.

In summary, 5-mFI was more accurate than ASA score in predicting post operative mortality in patients with rectal cancer, first because it has a significantly better AUC (AUC = 0.93) than the AUC of the ASA score (AUC = 0.81), when using ROC curves analysis, and second because it was the only independent predictive factor of mortality after multivariate analysis.

We think that our results would support a multicenter international study to confirm the findings, and if supported, 5-mFI should be considered in the preoperative evaluation of patients with rectal cancer instead of ASA score.

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#### Ethical approval

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### Author contribution

Mahdi Bouassida and Hazem Beji did the conception and design of the work, the data collection, the data analysis and interpretation, and the writing of the manuscript. Yessin Kallel, Mohamed Fadhel Chtourou, and Houada Belfkih participated in the writing of the manuscript. Bacem Trabelsi and Hassen Touinsi did the critical revision of the article and the final approval of the version to be published.

### Please state any conflicts of interest

No conflicts of interest.

### Registration of research studies

1. Name of the registry:
2. Unique Identifying number or registration ID:
3. Hyperlink to your specific registration (must be publicly accessible and will be checked):

### Guarantor

Mahdi Bouassida.  
Hazem Beji.

### Consent

Not required.

### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amsu.2022.104548>.

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