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TITLE PAGE

Title: Preoperative Low Muscle Mass Is Associated With Major Complications and Lower Recurrence-Free Survival After Gastric Cancer Surgery

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ABSTRACT

Background: Low muscle mass (LMM) has been associated with postoperative morbidity. This study aimed to examine the relationship between preoperative LMM and major postoperative complications and survival in patients undergoing curative resection for gastric cancer.

Method: A single-centre retrospective cohort study was conducted on consecutive patients who underwent surgical resection for gastric adenocarcinoma between 2008 and 2018. Patient demographics, radiological parameters, pathological data and complications were recorded. Skeletal muscle index was calculated using OsiriX software by manually measuring the cross-sectional skeletal muscle area at the third lumbar vertebra and correcting to the patient's height. Univariate and multivariate analyses were used to identify the risk factors associated with the outcomes.

Results: A total of 62 patients (36 males, mean age 68.3 ± 1.5 years) met the inclusion criteria. Twenty-six patients (41.9%) had LMM preoperatively. Demographic data in the non-LMM and LMM groups were equally matched except for body mass index (27.6 ± 0.8 kg/m^2 vs 24.3 ± 1.1 kg/m^2; p=0.012) and serum albumin (36.7 ± 0.7 g/l vs 33.8 ±1.0 g/l; p=0.017), which were higher in the non-LMM. LMM was associated with higher incidence of total (35.5% vs 64.5%; p=0.006), minor (40% vs 60%; p=0.030), major (9.1% vs 90.9%; p=0.004) postoperative complications, and decreased recurrence-free survival (hazard ratio 2.29; 95% CI 1.10 – 4.77; p=0.027).

Conclusion: LMM is a significant independent risk factor for major postoperative complications and recurrence-free survival after gastrectomy. Preoperative identification of

LMM could be a useful tool for prognostication and may identify a group suitable for prehabilitation.

Keywords: Low muscle mass, Gastrectomy, Skeletal muscle index

INTRODUCTION

Gastric cancer is the fifth most common malignancy and the third most common cause of cancer-related death worldwide.[1] Multi-modality therapy for gastric cancer provides the highest chance for a cure; however, surgical resection is the mainstay of treatment.[2] Enhancement in surgical techniques and perioperative care for gastric cancer has decreased overall postoperative morbidity and mortality, yet the incidence of these remain high.[3]

Sarcopenia is defined by the European Working Group on Sarcopenia in Older People (EWGSOP) as a syndrome characterised by progressive and generalised loss of skeletal muscle mass and strength correlated with physical disability, poor quality of life and death.[4] The rationale for the use of both muscle mass and strength is that muscle strength does not depend solely on mass, and the relationship between strength and mass is not linear.[4] EWGSOP recommended using skeletal muscle index measurement to identify low muscle mass (LMM).[4] There are multiple tools for measuring skeletal muscle index (SMI), including bioelectrical impedance analysis, dual-energy X-ray absorptiometry, magnetic resonance imaging, and computed tomography (CT) scan.[4, 5] With significant advances in its technology, CT has become the most commonly used cross-sectional imaging modality and the standard imaging tool in daily clinical settings.

There is a well-established negative relationship between sarcopenia or LMM and surgical patient outcomes that have been investigated in a number of different cancers such as oesophageal,[6] pancreatic,[7] colorectal,[8] and liver[9] malignancies. However, there is a relative paucity of published data examining this relationship for gastric cancer.[10] The calculation of SMI on computed tomography (CT) scan prior to surgery and identification of patients with LMM may be useful to help prognostication and also to help stratify higher-risk individuals.

This study aimed to determine the association of preoperative LMM defined by SMI on postoperative hospital and intensive care unit (ICU) length of stay (LOS), morbidity, long-term overall survival (OS) and recurrence-free survival (RFS) in patients who underwent potentially curative resection for gastric cancer.

MATERIALS AND METHODS

All patients with gastric adenocarcinoma who underwent curative-intent gastrectomy between 1st January 2008 and 31st December 2018 were retrospectively identified through a review of procedure codes from the International Classification of Diseases Tenth Revision, Clinical Modifications (ICD-10-CM) and cross-referenced with postoperative histopathological data.

Patients who had a staging CT scan within three months of surgery were included. If a patient had multiple CT scans within three months of surgery, the initial staging CT was utilised for SMI assessment. Patient information was obtained by review of both paper and electronic medical records including demographics, neoadjuvant therapy type (i.e.: Epirubicin, Cisplatin, and 5-florouracil [ECF]; Docetaxel, Oxaliplatin, Leucovorin, and 5-fluorouracil [FLOT]; Trial of Preoperative Therapy for Gastric and Esophagogastric Junction Adenocarcinoma [TOP GEAR]), comorbidities, surgical parameters (i.e. type and methods of surgery), postoperative tumour staging according to the American Joint Committee on Cancer (AJCC) eighth edition,[11] and postoperative complications, ICU- and hospital LOS. The Charlson Comorbidity Index (CCI) was calculated from patient preoperative information. The severity of complications was graded according to the Clavien-Dindo classification system, with minor complications defined as Clavien-Dindo < 3a and major

complications as Clavien-Dindo ≥ 3a.[12, 13] All patients underwent dietitian review for nutritional assessment at baseline with follow up depending on their level of nutritional risk.

Diagnosis of LMM

The diagnosis of LMM was made based on the staging CT scan, which was performed prior to neoadjuvant therapy (if patients underwent neoadjuvant) or preoperatively (if no neoadjuvant treatment was used), and was consistent for all patients. CT scans were analysed using the OsiriX software version 5.0.2 32-bit. CT images were analysed by a reviewer blinded to the patients' demographics and outcome using the following standardised approach. Two sequential scans at the third lumbar vertebra, in which both transverse processes were visible, were selected. Skeletal muscle coverage was defined using -30 to +150 Hounsfield unit thresholds.[14] The average hand-drawn muscle area of these two images was used. SMI was defined as the cross-sectional skeletal muscle area (cm^2) normalised with the patient's height (m). Subsequently, all images and measurements were verified by a Board-Certified Radiologist. LMM thresholds defined by Martin et al.[5] are commonly cited and used for patient stratifications; these are derived from a cohort of lung or gastrointestinal cancer patients and the threshold was adjusted for men according to their BMI. LMM in women is defined as an SMI being below 41 cm^2/m^2. In men with BMI < 25 kg/m^2, LMM is defined as an SMI below 43cm^2/m^2 and in men with BMI ≥ 25 kg/m^2 LMM is defined as an SMI below 53 cm^2/m^2.[5] An example of an analysed CT scan between non-LMM and LMM patients is shown in Figure 1.

Statistical analysis

Statistical analysis was performed using the IBM SPSS v26.0 software (IBM, NY, USA). The independent t-test and Mann-Whitney U test were used to compare continuous variables.

The χ^2 test and Fisher's exact test were used to compare categorical variables. Cox proportional hazard modelling was used to determine independent predictors of survival. Generalised linear model was used to determine univariate and multivariate predictors for morbidity. Univariable predictors yielding $p<0.2$ were entered into the multivariable model as covariates. The association between LMM and outcomes of interest was analysed by univariate and multivariate regression analyses. All data were expressed as mean ± standard error of mean (SEM) and statistical significance was defined as a p-value <0.05.

RESULTS

Ninety-three patients underwent curative-intent gastrectomy for gastric cancer during the study period. Twenty patients were excluded as they did not have available CT scans within the required time frame. Eleven patients were treated for disease other than adenocarcinoma and therefore excluded. The remaining 62 patients (36 males and 26 females; mean age 68.3 ± 1.5 years) were included in the study. Patient demographics, clinical indices and pathological data are summarised in Table 1. The non-LMM and LMM groups were well matched based on preoperative characteristics, including comorbidities, except for BMI and serum albumin, which were significantly lower in the LMM group.

There was a mean of 28 days from the date of the preoperative CT scan to the date of surgery. The distribution of SMI values is shown in Figure S1. The overall mean SMI was 46.1 cm^2/m^2 (Figure S1A) with the average values for men and women 48.9 cm^2/m^2 (Figure S1B) and 42.2 cm^2/m^2 (Figure S1C), respectively. According to the definition by Martin et al. of SMI threshold values,[5] 26 patients (41.9%; 15 males and 11 females) demonstrated preoperative LMM.

Operative details and postoperative outcomes are shown in Table S1 and Table S2, respectively. There was no statistically significant difference in the pathological staging, total LOS and the number of ICU bed hours between the two groups (p=0.35, p=0.06 and p=0.24, respectively). The mean follow-up time was 29.6 months. A summary of univariate and multivariate cox regression analyses for OS and RFS is presented in Table 2A and Table 2B, respectively. In the univariate regression analysis, LMM and tumour stages ≥3A were statistically significant prognosticators of both OS and RFS. In the multivariate analysis, only tumour stages ≥3A (HR 4.16; 95%CI: 1.14 - 15.15; p=0.030) was a significant predictor of poor OS and only LMM (HR 2.29; 95%CI:1.10 - 4.77; p=0.027) was a significant predictor of poor RFS.

One or more postoperative complications occurred in 35 (56.5%) patients, which was higher in the LMM group (20 [76.9%] patients vs. 15 [41.7%] patients; p=0.017). The LMM group had significantly higher rates of total complications (49 [64.5%] vs 27 [35.5%] complications; p=0.006), minor complications (39 [60%] vs 26 [40%] complications; p=0.030), and major complications (10 [90.9%] vs 1 [9.1%] complications; p=0.004) as illustrated in Figure 2A. Preoperative LMM was also specifically associated with a higher incidence of complications in pulmonary and gastrointestinal systems (p=0.003 and p=0.003, respectively), Figure 2B. The incidence of pulmonary and gastrointestinal complications is shown in Table S3. Univariate and multivariate regression analyses that were used to identify factors associated with major complications are shown in Table 3. LMM was a significant predictor in univariate and multivariate analysis for incidence of major complications.

DISCUSSION

This study provides further evidence in support of the adverse relationship between preoperative LMM and postoperative outcomes following curative-intent gastrectomy. Previous studies have investigated this relationship.[15-17] Consistent with this study, LMM has been associated with lower serum albumin,[16, 18] an increase in the incidence of major postoperative complications,[15, 18, 19] decreased RFS,[16, 20] but no increase in postoperative ICU stay or hospital LOS,[19, 21] and OS.[17]

In this series LMM was a significant predictor of OS in the univariate analysis, however was not a statistically significant predictor in the multivariate analysis of OS. This outcome may have been confounded due to the small sample size and loss to follow up; however, is consistent with previous published studies.[22-24]

LMM in cancer patients is partly due to cachexia-associated processes.[25] The number of studies in cancer patients investigating the association between LMM and clinical outcomes is rapidly increasing.[7, 10] However, as yet, there is no consensus on a standard approach to measure LMM, and different cut-off points or devices, have been published.[4]

Sarcopenia is characterised as a progressive loss of skeletal muscle mass and strength, associated with poor quality of life.[4] Sarcopenia is dependent on the relationship between LMM, low muscle strength, and impaired physical performance.[4] Rather than being a direct surrogate of sarcopenia, LMM is one of the key factors involved in its development and has previously been associated with an increased incidence of postoperative complications.[26] Future research endeavours that encompass the functional deficits of sarcopenia, as opposed to a purely radiological diagnosis, would be of great value in understanding the clinical outcomes of this disease process.

The specific mechanisms which underly the relationship between LMM and poor outcomes in patients with gastric cancer remain poorly defined. Skeletal muscle has been identified as a potential central regulator of the immune system.[25] In LMM patients, this interaction may be disturbed, leading to chronic, low-grade inflammation resulting in immune dysfunction.[27, 28] These factors may, in part, explain the relationship between LMM and the higher risk of complications.[28, 29]

Pulmonary complications are more frequent in the LMM group. Previous publications have documented in LMM a decline in the ability to perform activities of daily living, delayed mobilisation,[19] and impairment of respiratory[30] and swallowing muscle groups (leading to difficulty clearing the airway after surgery).[31] All of these factors, especially in patients with preoperative lung disease, may result in a higher incidence of postoperative pneumonia and atelectasis. In addition, LMM-related impaired immune response and increased inflammatory activity may contribute to the development of pneumonia.[32, 33]

In various malignancy types, tumour stage has previously been shown to be related to LMM and worse outcome.[34, 35] In patients with advanced gastric cancer, this may be magnified by additional insufficient oral intake, secondary to disease-specific symptoms, such as dysphagia, nausea, vomiting, loss of appetite and effects of mechanical obstruction can be associated with concurrent nutritional depletion and result in a worsening muscle loss and postoperative complications.[19]

Increased awareness among patients and healthcare providers, early screening, and a multi-disciplinary approach, especially personalised dietitian input to the treatment of LMM before surgical intervention, may be the best current practice to minimise the overall adverse impact

of LMM and subsequently postoperative complications in this group.[36, 37] It is recommended that surgical units ensure patients are routinely reviewed by a dietitian after cancer diagnosis and perioperatively. In 2010, the Society for Sarcopenia, Cachexia and Wasting Disease purported that adequate energy and protein intake in addition to the importance of physical exercise have been emphasised as the pivotal components in the management of sarcopenia and muscle loss.[38] A minimum of 20 to 30 minutes of resistance and aerobic exercise three times a week is recommended to slow muscle loss and sarcopenia.[38] It is extremely important to note that adequate protein supplementation alone only slows, but does not stop, loss of muscle mass, or results in muscle gain.[38]

Improvement of postoperative outcomes has been demonstrated in sarcopenic gastric cancer patients with preoperative exercise and nutritional support.[39] Following an assessment of calorie and protein intake in preoperative sarcopenic patients, nutritional support was provided for three weeks aiming for sufficient daily intake of calories and protein, in addition to preoperative exercise interventions which consisted of handgrip training, walking and resistance training.[39] In this series by Yamamoto et al, no major complications were seen in the sarcopenic group, suggesting that even with a very short period of intervention, preoperative nutritional and exercise interventions can be beneficial.[39]

Several limitations can be noted within our study. Firstly, observational bias is a potential drawback of any retrospective study as this may have influenced the data collection process through under-reporting both variables and outcome. The study was completed at a single centre and may have therefore suffered from selection bias and limits the ability to generalise our results to other centres. Even though the results are comparable with similar papers studying the effect of LMM in different types of cancer patients, the number of patients was

relatively small. On the other hand, this study confirmed the findings in previous studies which demonstrated a robust association between LMM and negative outcomes. Fourthly, we recognised that diverse ethnicities have different normal skeletal muscle mass cut-offs; however, the ethnicity of patients was not recorded as part of our database. Additional research is required to determine the difference of LMM's cut-off values between ethnicities. Furthermore, the definition of LMM group was based on patients with gastric cancer, which was appropriate in this setting. However, we acknowledged that this group might deviate from the standard definitions of LMM in healthy adults. The confounding variables, such as operation type and stage, might closely correlate with LMM, which was uncontrolled in this retrospective study. Future prospective research is suggested to define the effects of these variables.

CONCLUSION

LMM is significantly associated with increased major postoperative complications and poorer recurrence-free survival in patients undergoing gastrectomy for gastric cancer. Preoperative identification and management of LMM may help identify higher-risk patients and improve clinical outcomes after gastrectomy.

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FIGURE LEGENDS

Figure 1. Representative axial CT scan of non-low muscle mass patient (A) with a skeletal muscle index of 51.8 cm2/m2 and low muscle mass patient (B) with a skeletal muscle index of 33.2 cm2/m2. The total skeletal muscle area (outlined in green) was measured on a CT slice at the level of third lumbar vertebra.

Figure 2. Complications between non-low muscle mass (LMM) and LMM groups. Minor and major complications (A) and complications per organ system (B).

LIST OF SUPPORTING INFORMATION

1. Document S1 (Ethics and funding)
2. Table S1 (Comparison of intraoperative data between non-low muscle mass and low muscle mass groups)
3. Table S2 (Comparison of postoperative data between non-low muscle mass and low muscle mass groups)
4. Table S3 (Pulmonary and gastrointestinal complications between non-low muscle mass and low muscle mass groups)
5. Figure S1 (Skeletal muscle index distribution in all-(A), male-(B), and female (C) patients with gastric adenocarcinoma)

TABLES

Table 1. Patient demographic and characteristics

Characteristics	All (n = 62)	Non-LMM (n = 36)	LMM (n = 26)	p-value
Age (years)	68.3 ± 1.5	67.3 ± 12.0	69.8 ± 2.1	0.40
Sex (%)				0.96
Male	36 (58.1)	21 (58.3)	15 (57.7)	
Female	26 (41.9)	15 (41.7)	11 (42.3)	
Height (cm)	165.9 ± 1.3	165.8 ± 2.0	165.9 ± 1.7	0.97
Weight (kg)	72.1 ± 2.0	75.6 ± 2.1	67.4 ± 3.5	0.05
BMI (kg/m^2)	**26.2 ± 0.7**	**27.6 ± 0.8**	**24.3 ± 1.1**	**0.012**
Charlson Comorbidity Index				0.65
Total score 1	0 (0.0)	0 (0.0)	0 (0.0)	
Total score 2	5 (8.1)	4 (11.1)	1 (3.8)	
Total score 3	6 (9.7)	2 (5.6)	4 (15.4)	
Total score 4	12 (19.4)	8 (22.2)	4 (15.4)	
Total score 5	14 (22.6)	8 (22.2)	6 (23.1)	
Total score 6	12 (19.4)	7 (19.4)	5 (19.2)	
Total score 7	6 (9.7)	2 (5.6)	4 (15.4)	
Total score 8	5 (8.1)	4 (11.1)	1 (3.8)	
Total score 9	0 (0.0)	0 (0.0)	0 (0.0)	
Total score 10	2 (3.2)	1 (2.8)	1 (3.8)	
Neoadjuvant therapy (%)				0.73
No therapy	39 (62.9)	22 (61.1)	17 (65.4)	
Chemotherapy ECF	15 (24.2)	10 (27.8)	5 (19.2)	
Chemotherapy FLOT	5 (8.1)	3 (8.3)	2 (7.7)	
Chemotherapy TOPGEAR	3 (4.8)	1 (2.8)	2 (7.7)	
ASA score (%)				0.31
Grade I	1 (1.6)	0 (0)	1 (3.8)	
Grade II	21 (33.9)	12 (33.3)	9 (34.6)	
Grade III	37 (59.7)	21 (58.3)	16 (61.5)	
Grade IV	3 (4.8)	3 (8.3)	0 (0)	
ECOG status (%)				0.33
0	52 (83.9)	32 (88.9)	20 (76.9)	
1	6 (9.7)	3 (8.3)	3 (11.5)	
2	4 (6.5)	1 (2.8)	3 (11.5)	
3 - 5	0 (0.0)	0 (0.0)	0 (0.0)	
Smoking status (%)				0.45
Never-smoked	29 (47.5)	17 (48.6)	12 (46.2)	
Ex-smoker	22 (36.1)	14 (40.0)	8 (30.8)	
Current smoker	10 (16.4)	4 (11.4)	6 (23.1)	
Preoperative blood test				
Albumin (g/L)	**35.4 ± 0.6**	**36.7 ± 0.7**	**33.8 ± 1.0**	**0.017**
CRP (mg/L)	11.8 ± 2.1	9.3 ± 1.9	15.4 ± 4.2	0.16
WCC (x10^9/L)	7.7 ± 0.4	7.9 ± 0.5	7.5 ± 0.6	0.60
Neutrophil (x10^9/L)	4.9 ± 0.3	5.1 ± 0.5	4.5 ± 0.3	0.32
Lymphocyte (x10^9/L)	2.1 ± 0.2	2.1 ± 0.2	2.2 ± 0.5	0.70
Platelet (x10^9/L)	276.4 ± 11.4	266.3 ± 13.6	289.7 ± 19.5	0.31
Neutrophil-Lymphocyte ratio	3.5 ± 0.6	3.8 ± 0.9	3.1 ± 0.5	0.50

Platelet-Lymphocyte ratio	168.3 ± 11.8	157.8 ± 15.7	182.0 ± 18.0	0.31
Pathological staging				0.35
0	4 (6.5)	3 (8.3)	1 (3.8)	
1A	6 (9.7)	4 (11.1)	2 (7.7)	
1B	4 (6.5)	2 (5.6)	2 (7.7)	
2A	9 (14.5)	6 (16.7)	3 (11.5)	
2B	16 (25.8)	10 (27.8)	6 (23.1)	
3A	13 (21.0)	8 (22.2)	5 (19.2)	
3B	6 (9.7)	1 (2.8)	5 (19.2)	
3C	2 (3.2)	2 (5.6)	0 (0.0)	
4	2 (3.2)	0 (0.0)	2 (7.7)	

LMM: low muscle mass; BMI: body mass index; ECF: Epirubicin, Cisplatin, and 5-florouracil; FLOT: Docetaxel, Oxaliplatin, Leucovorin, and 5-fluorouracil; TOP GEAR: Trial of Preoperative Therapy for Gastric and Esophagogastric Junction Adenocarcinoma; ASA: American Society of Anaesthesiologists; ECOG: Eastern Cooperative Oncology Group; CRP: C-reactive protein; WCC: white cell count

Table 2. Univariate and multivariate cox regression analyses of overall survival (A) and recurrence-free survival (B)

2A. Characteristics	**Univariate OS**			**Multivariate OS**		
	HR	**95% CI**	**p-value**	**HR**	**95% CI**	**p-value**
Age	1.01	0.98 - 1.05	0.48			
Sex (male)	1.46	0.71 - 2.99	0.30			
BMI	0.97	0.90 - 1.06	0.52			
Low muscle mass	**2.17**	**1.02 - 4.63**	**0.044**	1.948	0.91 - 4.19	0.088
Current smoker	1.18	0.45 - 3.08	0.74			
ASA score ≥ 3	1.16	0.53 - 2.55	0.71			
ECOG status ≥ 2	2.14	0.64 - 7.20	0.22			
CCI ≥ 5	0.80	0.39 - 1.65	0.54			
Neoadjuvant therapy	0.63	0.29 - 1.37	0.24			
Albumin	0.97	0.89 - 1.06	0.54			
Total gastrectomy	1.67	0.81 - 3.47	0.17	1.17	0.54 - 2.53	0.69
Stage						
≤1B	1			1		
2A – 2B	2.82	0.80 - 9.91	0.11	2.54	0.72 - 9.01	0.15
≥3A	**4.81**	**1.38 - 16.77**	**0.014**	**4.16**	**1.14 - 15.15**	**0.030**

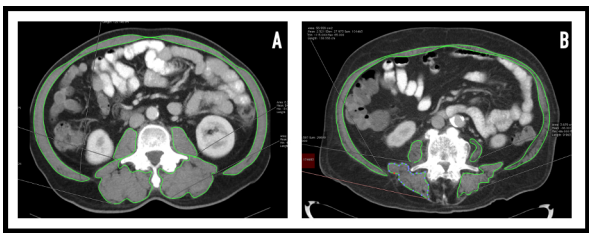
2B. Characteristics	**Univariate RFS**			**Multivariate RFS**		
	HR	**95% CI**	**p-value**	**HR**	**95% CI**	**p-value**
Age	1.01	0.98 - 1.04	0.52			
Sex (male)	1.65	0.83 - 3.27	0.15	1.71	0.84 - 3.49	0.14
BMI	0.95	0.88 - 1.03	0.21			
Low muscle mass	**2.56**	**1.25 - 5.26**	**0.010**	**2.29**	**1.10 - 4.77**	**0.027**
Current smoker	1.02	0.39 - 2.63	0.98			
ASA score ≥ 3	1.00	0.48 - 2.06	0.99			
ECOG status ≥ 2	2.72	0.94 - 7.85	0.06	1.41	0.49 - 4.06	0.53
CCI ≥ 5	0.83	0.42 - 1.67	0.61			
Neoadjuvant therapy	0.77	0.37 - 1.59	0.48			
Albumin	0.97	0.90 - 1.05	0.48			
Total gastrectomy	1.66	0.83 - 3.33	0.15	1.20	0.58 - 2.49	0.63
Stage						
≤1B	1			1		
2A – 2B	1.69	0.60 - 4.75	0.32	1.34	0.47 - 3.83	0.59
≥3A	**3.11**	**1.13 - 8.57**	**0.028**	2.45	0.86 - 6.99	0.09

BMI: body mass index; ASA: American Society of Anaesthesiologists; ECOG: Eastern Cooperative Oncology Group; CCI: Charlson Comorbidity Index; OS: overall survival; RFS: recurrence-free survival

Table 3. Univariate and multivariate regression analyses for risk factors of major complications.

Characteristics	Univariate			Multivariate		
	OR	95% CI	p-value	OR	95% CI	p-value
Age	1.02	0.95 - 1.09	0.57			
Sex (male)	0.65	0.15 - 2.89	0.57			
BMI	0.93	0.80 - 1.08	0.34			
Low muscle mass	**15.56**	**1.80 - 134.24**	**0.013**	**12.87**	**1.42 - 116.50**	**0.023**
Current smoker	1.67	0.19 - 15.10	0.65			
ASA score ≥ 3	1.12	0.25 - 4.99	0.88			
ECOG status ≥ 2	2.08	0.19 - 22.58	0.55			
CCI ≥ 5	1.21	0.27 - 5.40	0.80			
Neoadjuvant therapy	1.43	0.34 - 5.98	0.62			
Albumin	0.89	0.76 - 1.03	0.12	0.95	0.81 - 1.11	0.48
Total gastrectomy	1.22	0.29 - 5.07	0.79			
Stage						
≤1B	1					
2A – 2B	1.18	0.19 - 7.37	0.86			
≥3A	1.08	0.16 - 7.44	0.94			

BMI: body mass index; ASA: American Society of Anaesthesiologists; ECOG: Eastern Cooperative Oncology Group; CCI: Charlson Comorbidity Index



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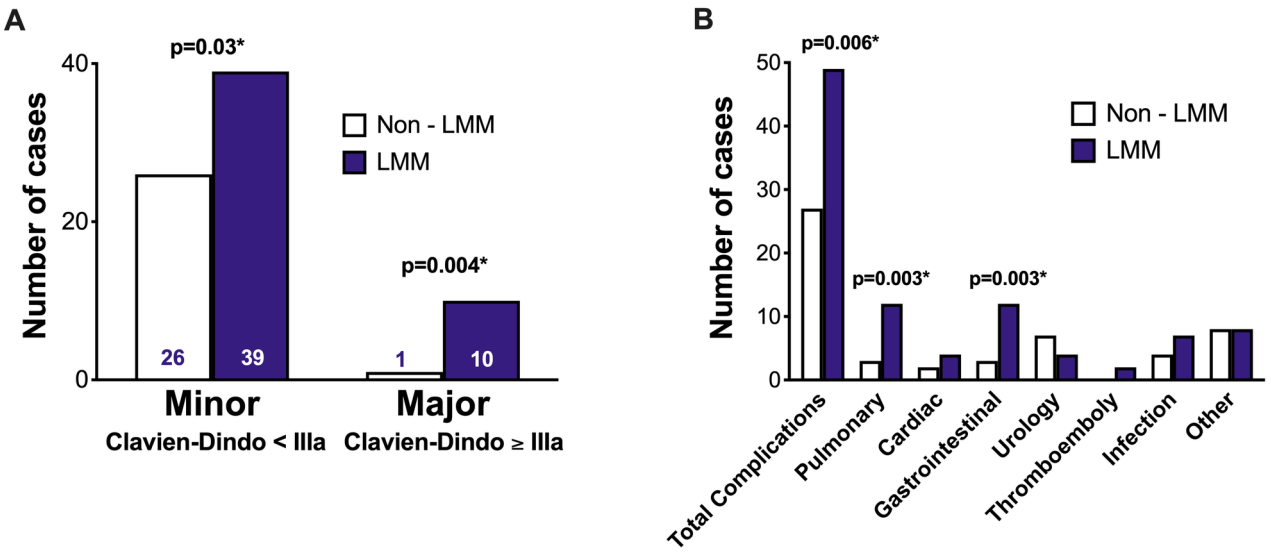

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