

Calf circumference is an independent predictor of postoperative complications in the surgical treatment of head and neck cancer

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ABSTRACT

Introduction: The prevalence of malnutrition is high among head and neck cancer (HNC) patients and negatively impacts their quality of life, treatment, and survival rates. **Objective:** To identify preoperative nutritional variables capable of predicting postoperative complications in surgically treated HNC patients. **Methods:** This was a prospective cohort study of HNC patients referred for surgery as initial treatment. **Results:** Sixty patients were included in the study; they had a median age of 65.5 years, were mostly men (85%), and most had low education levels (90%) and low household income (78.3%). The incidence rate of severe postoperative complications (grades II, III, IV, and V according to the Clavien-Dindo grading system) was found to be 50%. The nutritional variables under investigation, namely calf circumference (CC), triceps skinfold, body mass index, and adductor pollicis muscle thickness were shown to predict postoperative complications in HNC patients, especially CC, which was found to be an independent predictor of complications (OR=0.8; 95%CI: 0.65–0.96). Each 1-cm increase in calf circumference was associated with a 20% decrease in the risk of postoperative complications. **Conclusion:** Our findings show the nutritional variables studied are useful in the prognostic assessment of HNC surgery.

Keywords: malnutrition; head and neck neoplasms; anthropometry.

INTRODUCTION

Cancer patients often develop changes in their nutritional status¹. Malnutrition is common in all types of cancer, with varying intensity according to the type and location of the tumor. In head and neck cancer (HNC) patients, malnutrition is one of the main reported consequences, with an incidence² rate of up to 72%.

The production of anorexigenic agents by the tumor leads to increased energy expenditure and contributes to weight loss and malnutrition³. The location of tumors in the upper aerodigestive tract causing pain, hindering bolus transit, and disturbing chewing

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and swallowing adds to the problem, resulting in a considerable reduction in food intake and marked weight loss⁴.

A compromised nutritional status negatively impacts patient quality of life, response to treatment, and survival rates. The increased risk of postoperative complications is well established for malnourished patients, including infectious complications, wound dehiscence, fistula formation, delayed wound healing, longer hospital stays, and increased public healthcare spending⁵.

However, the prognostic potential of nutritional variables has been understudied in HNC patients⁵. Nutritional status assessment is of fundamental importance in the preoperative evaluation of these individuals to identify patients at increased risk of malnutrition and thus prevent the adverse effects on postoperative recovery resulting from a compromised nutritional status.

This assessment can be carried out in a simplified manner using anthropometric measurements, which are non-invasive, cheap, and universally applicable⁶. Based on these considerations, we hypothesize simplified nutritional variables evaluated preoperatively can predict postoperative complications.

The objective of this study is to assess the prognostic accuracy of simplified anthropometric variables in predicting postoperative complications in HNC patients.

METHODS

This is a prospective cohort study with HNC patients who were seen in two tertiary centers (Hospital Dom Pedro de Alcântara and Hospital Otorrinolaringológico/Multiclin), both located in Feira de Santana, Brazil, between November 2016 and November 2019.

All patients older than 18 years of age who were eligible for en bloc surgery (removal of the primary tumor and neck dissection) as the initial treatment of T2–T4⁷ epidermoid carcinoma of the oral cavity, larynx, or hypopharynx were consecutively included in the study.

Patients were classified by their comorbidities according to the Charlson Comorbidity Index⁸ and the American Society of Anesthesiologists (ASA) criteria for the assessment of perioperative mortality⁹.

The anthropometric evaluation was carried out by an experienced dietitian during a preoperative visit and included weight measurement with a Welmy[®] mechanical scale, with a 150-kg capacity, and height measurement with an attached stadiometer. Patient positioning for these measurements conformed to the rules described by Lohman¹⁰. The body mass index (BMI) was obtained by dividing the weight in kilograms by the square of the height in meters¹¹.

A Seca[®] inelastic fiberglass measuring tape was used to measure arm circumference (AC) and calf circumference (CC) to the nearest 0.1 cm. A Lange[®] skinfold caliper was used to measure triceps skinfold (TSF) and adductor pollicis muscle thickness (APMT)¹².

Participants were followed up from the day of surgery until hospital discharge and were monitored for potential clinical complications. Surgical complications were classified according to the Clavien-Dindo grading system, validated in Brazil for HNC surgical cases. Grades II, III, IV, and V were considered for postoperative complications, including the need for blood transfusion, organ dysfunction, repeat surgical intervention and death¹³.

Quantitative variables are presented as medians and interquartile ranges. The Mann-Whitney test was used to compare continuous variables. Significant variables ($p < 0.05$) as determined by univariate analysis were included in the logistic regression to identify potential independent predictors of postoperative complications. The receiver operating characteristic (ROC) curve was used to assess the predictive properties of the variables under investigation. Commercially available statistics software GraphPad Prism (version 6.02 for Windows, San Diego, CA, USA) was used for statistical analysis.

This project was approved by our institutional review board under protocol no.1.399.962, and all patients provided written informed consent.

RESULTS

Sixty-seven individuals were included in this study, but 7 of them (10.4%) were excluded as the proposed treatment was not completed. Our sample comprised 60 subjects, with a median age of 65.5 years (55–75 years). They were mostly men (85%), most had low education levels (90%) and low household income (78.3%), and the majority of them reported consuming alcohol (91.7%) and tobacco (90%) (Table 1).

Patient preoperative clinical data are shown in Table 2. Most HNC cases included in the present study were primarily in the larynx (51.6%) and the oral cavity (48.4%). In addition, most patients had stage IV (48.3%) and stage III (26.7%) tumors.

Postoperative complications occurred in 50% of patients. Anthropometric variables for the occurrence of postoperative complications are shown in Table 3. In patients who had postoperative complications, median BMI ($p = 0.024$), CC ($p = 0.009$), TSF ($p = 0.01$), and APMT ($p = 0.04$) were found to be lower than in those with an uncomplicated postoperative course.

ROC curves showed the nutritional variables assessed in this study had similar abilities (Figure 1) to predict postoperative complications in HNC patients. CC and TSF fared best, with accuracies of 0.70 (95%CI: 0.58–0.82) and 0.68 (95%CI: 0.56–0.80), respectively, and were followed by BMI (accuracy of 0.67; 95%CI: 0.53–0.78) and APMT (0.64; 95%CI: 0.50–0.76).

After logistic regression analysis, CC was found to be an independent predictor of postoperative complications in our sample (OR=0.80; 95%CI: 0.65–0.96), i.e., each 1-cm increase in CC was associated with a 20% decrease in the risk of postoperative complications.

Table 1: Sociodemographic and lifestyle data of head and neck cancer patients.

Variables	Total (n=60)
	n (%)
Sex	
Male	51 (85.0%)
Female	9 (15.0%)
Education level	
Illiterate	13 (21.7%)
Primary education	41 (68.3%)
Secondary education	6 (10.0%)
Household income	
0–1 Minimum wage	48 (78.3%)
> 1 Minimum wage	13 (21.7%)
Alcohol consumption	
Yes	55 (91.7%)
No	5 (8.3%)
Tobacco smoking	
Yes	54 (90.0%)
No	6 (10.0%)

Table 2: Preoperative clinical data of head and neck cancer patients.

Variables	Total (n=60)
	n (%)
Primary site	
Oral cavity	29 (48.4%)
Larynx	31 (51.6%)
Primary subsite	
Tongue	8 (13.33%)
Buccal mucosa	2 (3.3%)
The floor of the mouth	14 (23.3%)
Tongue base	4 (6.7%)
Lower gingiva	1 (1.7%)
Aryepiglottic fold	1 (1.7%)
Glottis	30 (50.0%)
Clinical staging	
II	15 (25.0%)
III	16 (26.7%)
IV	29 (48.3%)
ASA physical status classification	
2	60 (100%)
Charlson Comorbidity Index	
0	37 (61.6%)
1	23 (36.7%)

DISCUSSION

BMI, CC, TSF, and APMT were found to have good prognostic accuracy in HNC patients eligible for surgery, especially CC, which was an independent predictor of postoperative complications in the present study.

Our sample is epidemiologically similar to other cohorts^{14,15}, indicating most HNC patients are elderly men and have low education levels, low income, and a lifestyle marked by the combined use of alcohol and tobacco^{2,15}. These characteristics contribute to the high frequency of late-stage tumors among them, as low socioeconomic status is associated with ignorance about HNC signs and symptoms as well as limited access to healthcare².

As for anthropometric data, our patients had a median BMI in the lower limit of normal¹⁶, since ours was a population of elders (median age of 65.5 years). Melo et al.¹⁷ also studied HNC patients preoperative BMI and found a similar mean value (23.3 ± 4.4 kg/m²).

In the present study, preoperative BMI had an accuracy of 67% in predicting postoperative complications but was not found to be an independent predictor after logistic regression analysis. Leung et al.² also found no association between BMI and postoperative complications in a retrospective analysis of 70 surgically treated HNC patients. In studies evaluating survival rates, BMI has nevertheless been deemed a good prognostic indicator^{18–20}.

This finding may be explained by the clinical limitations of BMI, which is a nonspecific indicator as it is calculated from gross body weight and so it may be influenced by confounding factors such as edema. In addition, cancer patients may have increased levels of proinflammatory cytokines, which may lead to reduced body cell mass and extracellular fluid volume expansion²¹. These patients may therefore have a normal BMI despite significant weight loss relative to their usual body weight, which is indicative of malnutrition.

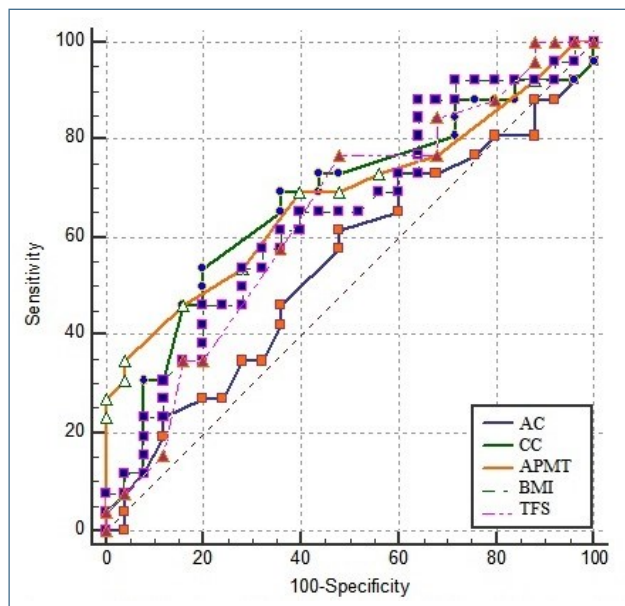
In the process of starvation and prolonged physiological stress, often seen in HNC patients, muscle protein is mobilized to meet acute-phase response energy demands, leading to lean body mass depletion. In this scenario, CC is considered a simple, sensitive measure of muscle mass in the elderly⁶, being able to predict functional decline, the longer length of hospital stay, and death²². To our knowledge, there are no published studies evaluating the role of CC in predicting postoperative complications.

CC yielded a prognostic accuracy of 70% in this study, proving to be an independent predictor of postoperative complications in HNC patients eligible for surgery. This finding is probably attributable to the ability of CC to detect muscle mass depletion and compromised nutritional status⁶, consequently being capable of predicting postoperative complications in our population.

Each 1-cm increase in CC was associated with a 20% decrease in the risk of postoperative complications. This suggests CC can be easily applied and interpreted in clinical practice as an indicator of reduced muscle mass and a predictor of postoperative complications in HNC surgery.

Table 3: Preoperative anthropometric indicators and postoperative complications in head and neck cancer patients.

Variables	Complications		p-value
	Clavien 0–I (n = 30)	Clavien II–V (n = 30)	
Body mass index (kg/m ²)	23.9 [22.0–26.9]	22.1 [19.3–24.4]	0.024
Arm circumference (cm)	27.0 [24.4–29.0]	25.7 [23.0–28.1]	0.147
Calf circumference (cm)	35.0 [33.0–37.0]	32.2 [30.7–35.0]	0.009
Triceps skinfold (mm)	10.0 [8.0–12.2]	8.0 [5.7–12.2]	0.011
Adductor pollicis muscle thickness (mm)	11.0 [9.0–14.0]	9.5 [5.7–12.2]	0.040

**Figure 1:** ROC curves for the preoperative nutritional variables were analyzed as predictors of postoperative complications in head and neck cancer patients. AC: arm circumference, CC: calf circumference, APMT: adductor pollicis muscle thickness, BMI: body mass index, TFS: triceps skinfold.

APMT is a cheap, straightforward means of estimating the loss of muscle mass²³. In the present study, this indicator of nutritional status was found to be able to predict postoperative complications with an accuracy of 0.64 (95%CI: 0.50–0.76).

To our knowledge, no similar studies evaluating APMT in HNC patients have been published so far. However, literature data from other fields have shown the application of this indicator in multiple clinical settings, with significant results for nutritional diagnosis and associations with both postoperative complications and length of hospital stay²⁴.

TSF estimates subcutaneous fat and reflects whole-body fat percentage⁶; malnourished individuals consequently show low TSF values. In this study, TSF yielded good accuracy in predicting postoperative complications in HNC patients, but few other studies have reported a similar analysis for this type of cancer. This finding points to the ability of this variable to detect malnutrition, especially in cases of severe body fat depletion, thus being capable of predicting undesirable clinical outcomes and postoperative complications associated with HNC surgery.

Lúis et al.²⁵ looked into the potential relationship of TSF and other indicators of nutritional status with the length of hospital stay and mortality rates in inpatients with varied conditions but found no statistically significant associations.

There are some limitations to this study, such as its single-center design and its limited sample size, which may have introduced selection bias. In addition, the reproducibility of anthropometric measurements requires training and compliance with standardized techniques. However, this is one of only a few studies looking into the applicability of nutritional variables in the surgical treatment of HNC, which should encourage further related research.

Conclusion

The nutritional variables studied, namely CC, TSF, APMT, and BMI, were shown to have good prognostic accuracy for HNC patients eligible for surgery, especially calf circumference, which was found to be an independent predictor of poor prognosis in this population.

Our results should warrant further research into the prognostic accuracy of nutritional variables in the preoperative evaluation of HNC patients and other clinical settings.

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