Mid-Upper Arm Circumference as an Indicator of Quality of Life of Patients with Advanced Cancer

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Abstract

Purpose

Mid-upper arm circumference (MUAC) has been used to assess malnutrition and health status across various disease groups. However, it is unclear whether MUAC is associated with quality of life (QOL) of patients with advanced cancer. Our goal was to investigate the relationship between MUAC and QOL in ambulatory out-patients with advanced cancer.

Method

This was a cross-sectional study conducted in a tertiary cancer center in South Korea. A total of 200 patients with advanced cancer at oncology clinics of Seoul National University Bundang Hospital from March 2016 to January 2019 were enrolled. Out-patients with advanced cancer whose survival was expected to be less than one year by their oncologists were enrolled. QOL of patients was evaluated using the European Organization for Research and Treatment of Cancer quality of life questionnaire core 30 (EORTC QLQ-C30). Associations of QOL with MUAC and nutritional parameters were examined with generalized linear models.

Results

The most common cancer sites were the lung, colon or rectum, and genitourinary tract. In univariate analyses, significant factors associated with higher summary score of EORTC QLQ-C30 were higher MUAC (≥ 26.5 cm, $p < 0.001$), higher body mass index (BMI) (≥ 22 kg/m^2, $p < 0.001$), higher serum albumin (≥ 3.7 g/dL, $p = 0.004$), higher creatinine (≥ 0.8 mg/dL, $p = 0.023$), and higher uric acid (≥ 5 mg/dL, $p = 0.001$). In multivariate analysis, higher serum albumin (≥ 3.7 g/dL, $p < 0.01$) and higher MUAC (≥ 26.5 cm, $p = 0.03$) were independently associated with better summary score of EORTC QLQ-C-30.

Conclusion

MUAC was highly associated with QOL in terms of summary score and overall health status. Thus, MUAC, with its simplicity, can be a useful tool to reflect QOL in patients with advanced cancer.

Introduction

Nutritional markers have been reported to be related to quality of life (QOL) of patients with advanced cancer. For instance, higher C-reactive protein (CRP) and lower albumin are well-known predictive laboratory markers of a lower QOL in patients with advanced cancer [19]. On the other hand, body mass index (BMI) plays a classical role in assessing QOL as an easily accessible tool in clinical practice. Recently, mid-upper arm circumference (MUAC) has also been shown as a simple and practical measure

of nutrition. Previous studies have demonstrated that MUAC can be an efficient tool to assess health status, disability, and mortality in the elderly[10, 23]. However, studies on the association between MUAC and QOL in patients with advanced cancer are scanty.

Malnutrition is one of the most common manifestations in patients with advanced cancer. It is well known as cancer anorexia cachexia syndrome (CACS). As diseases progress, patients usually go through weight loss and deterioration in physical function due to CACS, eventually leading to reduced QOL [4, 16]. In patients with far advanced cancer, enhancing quality of life (QOL) is the main goal of care and a priority for patients themselves [9, 17]. Especially when patients have less than a year's life expectancy, they undergo a rapid decline of functional status. Therefore, monitoring QOL is necessary to intervene QOL of patients during their end-of-life.

Anthropometric measurements are non-invasive and easy-to-use tools to assess nutritional status in clinical settings [21]. Laboratory parameters including white blood cell count, lymphocyte percentage, serum albumin level, and CRP are also correlated well with nutritional status [6]. Among those, MUAC is advantageous as a simple and inexpensive measure. Patients and their caregivers can monitor MUAC at home when they are appropriately guided. This study hypothesized that MUAC could be a useful indicator to reflect QOL. If a simple measurement such as MUAC can reflect QOL well, it could be a helpful and convenient method to patients and clinicians. Thus, the aim of this study was to investigate the relationship between MUAC and QOL in patients with advanced cancer.

Subjects And Methods

Patients

This was a cross-sectional single-center prospective observational study. Patients who received chemotherapy at oncology clinics of Seoul National University Bundang Hospital from March 2016 to January 2019 were enrolled. Inclusion criteria were as follows: (1) adult (age ≥ 18 years), and (2) diagnosis of advanced cancer, having estimated prognosis within one year by their oncologists Advanced cancer was defined as a metastatic or recurrent disease or progressive locally advanced disease not amenable to curative treatment. Exclusion criteria were: (1) hematologic malignancies, (2) clinician's prediction of survival within one month, and (3) inability to communicate. Written informed consent was obtained from each patient before enrollment. This study was approved by the Institutional Review Board (IRB) of Seoul National University Bundang Hospital (IRB number: B-1601/332-302).

Data collection

A clinical research nurse interviewed all enrolled patients. The nurse evaluated patient performance with the Eastern Cooperative Oncology Group (ECOG) performance status. Patient's QOL was assessed with European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 (EORTC QLQ-C30) score. The questionnaire was self-administered. However, when a patient was too emaciated or needed additional help to answer, the research nurse provided explanation about the

questionnaire. The score was calculated based on the EORTC QLQ-C30 scoring manual [1]. In this QOL questionnaire, scales for physical, emotional, cognitive, and social functioning and for global quality of life were calculated from relevant questions. These scales ranged from 0 (worst) to 100 (best). Single-item scores for questions 29 (overall physical condition) and 30 (overall quality of life), seven-point scales which combine to form the global QOL scale. Global health status/Quality of life scale of the EORTC QLQ-C30 reflects overall health and quality of life by one single last item. Summary score of the EORTC QLQ-C30 was based on the sum of all scales of the QLQ-C30, excluding the scale for financial difficulties and global health status. A higher summary score meant a better QOL. Demographic data and clinical information including age, sex, primary cancer site, anticancer treatment, date of advanced cancer diagnosis, and date of diagnosis as incurable were obtained. Laboratory data (hemoglobin, lymphocyte, serum albumin, alanine transaminase, aspartate transaminase, uric acid, blood urea nitrogen, creatinine) were collected from electronic medical records. Regarding nutritional assessment, the research nurse measured mid-upper arm circumference (MUAC) of each patient. The circumference of upper arm was measured at the mid-point between the most prominent tip of the shoulder and the elbow. Other nutritional markers such as body weight and height were collected from electronical medical records. BMI was calculated separately afterwards.

Statistical Analysis

First, descriptive analyses were performed to summarize baseline characteristics of enrolled patients. Each nutritional marker (MUAC, BMI, laboratory variables) was categorized into two groups based on their mean by descriptive analyses. Second, Student's t-test was performed to compare domain scores of EORTC QLQ-C30 according to two groups categorized by their means of each nutritional marker. Third, a generalized linear model analysis was performed to evaluate the association of QOL and MUAC. Summary score and global health status domain score were representatively used for the evaluation of QOL. Final models were adjusted for laboratory variables. BMI was excluded because of a collinearity issue. MUAC and variables with p values less than 0.05 in univariate analysis were entered into the multivariate analysis. All analyses were performed using IBM Statistical Package for Social Science (SPSS) Statistics for Windows, version 24.0 (IBM Corp., Armonk, NY, USA).

Results

A total of 200 patients with advanced cancer from March 2016 to January 2019 were enrolled (Table 1). The mean patient age was 64.5 (standard deviation [SD]: 11.5) years. There were 128 (64%) male patients. The most common cancer site was the lung (30.5%), followed by colon or rectum (12.5%), genitourinary tract (11.5%), and stomach (10.0%). At the time of enrollment, 65% of patients were undergoing palliative chemotherapy. A total of 66% of patients had an ECOG performance status of 0 or 1.

Table 1
Characteristics of Enrolled Patients (n = 200)

Characteristics	n (%)
Age (years, mean ± SD)	64.5 ± 11.5
Gender	
Male	128 (64.0)
Female	72 (36.0)
Primary cancer site	
Lung	61 (30.5)
Stomach	20 (10.0)
Colon/Rectal	25 (12.5)
Ovary/Cervical	4 (2.0)
Liver/Biliary-tract	4 (2.0)
Pancreas	3 (1.5)
Esophagus	5 (2.5)
Head/Neck	2 (1.0)
Soft tissue	5 (2.5)
Kidney/Bladder	23 (11.5)
Others	48 (24.0)
Undergoing chemotherapy (Yes)	131 (64.9)

Abbreviations: ALT, alanine transaminase; AST, aspartate transaminase; BMI, body mass index; BUN, blood urea nitrogen; CRP, C-reactive protein; ECOG, Eastern Cooperative Oncology Group; EORTC QLQ-C30, the European Organization for Research and Treatment of Cancer quality of life questionnaire core 30; n, number; SD, standard deviation

Global health status/Quality of life scale of the EORTC QLQ-C30 reflects overall health and quality of life by one single last item.

Summary score of the EORTC QLQ-C30 was based on the sum of all scales of the QLQ-C30, excluding the scale for financial difficulties and global health status.

Characteristics	n (%)
ECOG performance status	
0	8 (4.0)
1	125 (61.9)
2	55 (27.2)
3	13 (6.5)
4	0 (0)

Abbreviations: ALT, alanine transaminase; AST, aspartate transaminase; BMI, body mass index; BUN, blood urea nitrogen; CRP, C-reactive protein; ECOG, Eastern Cooperative Oncology Group; EORTC QLQ-C30, the European Organization for Research and Treatment of Cancer quality of life questionnaire core 30; n, number; SD, standard deviation

Global health status/Quality of life scale of the EORTC QLQ-C30 reflects overall health and quality of life by one single last item.

Summary score of the EORTC QLQ-C30 was based on the sum of all scales of the QLQ-C30, excluding the scale for financial difficulties and global health status.

Characteristics	n (%)
EORTC QLQ-C30 Score (mean ± SD)	
Functional scales	57.3 ± 23.3
Physical	52.8 ± 30.0
Role	74.3 ± 22.0
Emotional	71.3 ± 21.7
Cognitive	57.8 ± 30.8
Social	
Symptom scale	47.8 ± 26.7
Fatigue	16.8 ± 23.6
Nausea and vomiting	37.3 ± 31.2
Pain	32.8 ± 32.0
Dyspnea	37.3 ± 32.8
Insomnia	46.8 ± 34.1
Appetite loss	27.2 ± 32.8
Constipation	11.3 ± 22.0
Diarrhoea	34.5 ± 32.5
Financial difficulties	48.0 ± 20.4
Global health status	65.9 ± 18.1
Summary score	

Abbreviations: ALT, alanine transaminase; AST, aspartate transaminase; BMI, body mass index; BUN, blood urea nitrogen; CRP, C-reactive protein; ECOG, Eastern Cooperative Oncology Group; EORTC QLQ-C30, the European Organization for Research and Treatment of Cancer quality of life questionnaire core 30; n, number; SD, standard deviation

Global health status/Quality of life scale of the EORTC QLQ-C30 reflects overall health and quality of life by one single last item.

Summary score of the EORTC QLQ-C30 was based on the sum of all scales of the QLQ-C30, excluding the scale for financial difficulties and global health status.

Characteristics	n (%)
Laboratory test results (mean ± SD)	
Hemoglobin (g/dL)	11.0 ± 1.9
Lymphocyte (%)	22.3 ± 10.9
Albumin (mg/dL)	3.7 ± 0.5
AST (IU/L)	39.1 ± 53.3
ALT (IU/L)	28.2 ± 33.1
Uric acid (mg/dL)	5.1 ± 1.7
Creatinine (mg/dL)	0.97 ± 0.8
Mid-upper arm circumference (cm, mean ± SD)	26.5 ± 3.8
Height (cm, mean ± SD)	161.6 ± 8.0
Weight (kg, mean ± SD)	58.8 ± 12.2
BMI (mean ± SD)	22.5 ± 3.9
Abbreviations: ALT, alanine transaminase; AST, aspartate transaminase; BMI, body mass index; BUN, blood urea nitrogen; CRP, C-reactive protein; ECOG, Eastern Cooperative Oncology Group; EORTC QLQ-C30, the European Organization for Research and Treatment of Cancer quality of life questionnaire core 30; n, number; SD, standard deviation	
Global health status/Quality of life scale of the EORTC QLQ-C30 reflects overall health and quality of life by one single last item.	
Summary score of the EORTC QLQ-C30 was based on the sum of all scales of the QLQ-C30, excluding the scale for financial difficulties and global health status.	

In univariate analyses results, statistically significant factors associated with higher summary score of EORTC QLQ-C30 were higher MUAC (≥ 26.5 cm, $p < 0.001$), higher BMI (≥ 22 kg/m^2, $p < 0.001$), higher serum albumin (≥ 3.7 g/dL, $p = 0.004$), higher creatinine (≥ 0.8 mg/dL, $p = 0.023$), and higher uric acid (≥ 5 mg/dL, $p = 0.001$) (Tables 2 and 3). There were no significant relationships among hemoglobin, lymphocyte, aspartate aminotransferase/aminotransferase ratio (AST/ALT), and MUAC in univariate analyses. In the multivariate analysis, higher serum albumin (≥ 3.7 g/dL, $p < 0.01$) and higher MUAC (≥ 26.5 cm, $p = 0.03$) were independently associated with better summary score of EORTC QLQ-C30 (Table 4).

Table 2
Means and Standard Deviations of EORTC QLQ-C30 Score by Anthropometric Measurement Groups

EORTC QLQ-C30	Mid-Upper Arm Circumference (cm)		P-value	Body Mass Index		P-value
	<26.5	>=26.5		<22	>=22	
n	94	99		105	95	
Functional scale						
Physical	51.4 ± 24.3	62.8 ± 21.3	0.001	51.9 ± 23.7	63.3 ± 21.5	0.001
Role	43.8 ± 28.5	61.1 ± 29.0	< 0.001	44.3 ± 28.6	62.1 ± 28.8	< 0.001
Emotional	73.7 ± 22.3	74.2 ± 21.8	-	73.2 ± 22.1	75.5 ± 21.9	-
Cognitive	66.0 ± 23.6	75.8 ± 19.2	0.002	66.3 ± 22.8	76.8 ± 19.2	0.001
Social	50.4 ± 31.1	64.6 ± 29.4	0.001	51.4 ± 31.3	64.7 ± 28.9	0.002
Symptom scale						
Fatigue	54.5 ± 26.4	41.5 ± 25.7	0.001	55.4 ± 25.7	39.3 ± 25.3	< 0.001
Pain	43.4 ± 31.1	32.3 ± 31.1	0.014	44.3 ± 30.1	29.5 ± 30.2	0.001
Dyspnea	34.8 ± 32.4	31.0 ± 32.4	-	35.2 ± 33.0	30.2 ± 30.1	-
Insomnia	42.2 ± 35.0	34.0 ± 30.5	-	42.9 ± 35.7	31.2 ± 28.3	0.011
Appetite loss	52.5 ± 36.1	41.1 ± 31.9	0.021	53.0 ± 34.5	40.0 ± 32.5	0.007
Constipation	27.3 ± 32.4	26.3 ± 32.7	-	26.7 ± 31.8	27.7 ± 33.9	-

P values were driven from t tests. – means insignificant P values (> 0.05).

Abbreviations: EORTC QLQ-C30, the European Organization for Research and Treatment of Cancer quality of life questionnaire core 30

Global health status/Quality of life scale of the EORTC QLQ-C30 reflects overall health and quality of life by one single last item.

Summary score of the EORTC QLQ-C30 is based on the sum of all scales of the QLQ-C30, excluding the scale for financial difficulties and global health status.

EORTC QLQ-C30	Mid-Upper Arm Circumference (cm)		P-value	Body Mass Index		P-value
Diarrhea	13.5 ± 23.6	9.1 ± 20.1	-	14.3 ± 24.0	8.1 ± 19.3	0.044
Financial difficulties	33.3 ± 30.5	36.0 ± 34.6	-	34.9 ± 31.5	34.0 ± 33.7	-
Global health status	44.1 ± 20.1	52.9 ± 19.5	0.003	43.7 ± 20.1	52.7 ± 19.8	0.002
Summary score	61.2 ± 17.9	70.0 ± 17.6	0.001	61.2 ± 17.5	71.0 ± 17.4	<0.001

P values were driven from t tests. – means insignificant P values (> 0.05).

Abbreviations: EORTC QLQ-C30, the European Organization for Research and Treatment of Cancer quality of life questionnaire core 30

Global health status/Quality of life scale of the EORTC QLQ-C30 reflects overall health and quality of life by one single last item.

Summary score of the EORTC QLQ-C30 is based on the sum of all scales of the QLQ-C30, excluding the scale for financial difficulties and global health status.

Table 3
Means and Standard Deviations of EORTC QLQ-C30 Score by Nutritional Markers

EORTC QLQ-C30	Albumin (g/dL)		P-value	Creatinine (mg/dL)		P-value	Uric acid (mg/dL)		P-value
	< 3.7	≥ 3.7		< 0.8	≥ 0.8		< 5	≥ 5	
n	84	116		98	102		101	99	
Functional scale									
Physical	50.4 ± 25.3	62.4 ± 20.4	<0.001	54.9 ± 24.4	59.7 ± 22.1	-	52.1 ± 23.2	62.6 ± 22.3	0.001
Role	45.2 ± 31.3	58.2 ± 27.8	0.002	48.5 ± 30.0	56.9 ± 29.5	0.047	45.4 ± 29.0	60.3 ± 29.2	<0.001
Emotional	74.0 ± 21.0	74.5 ± 22.7	-	71.2 ± 23.1	77.3 ± 20.5	0.049	71.7 ± 23.4	76.9 ± 20.2	-
Cognitive	67.9 ± 23.0	73.9 ± 20.5	-	68.5 ± 23.4	74.0 ± 19.7	-	68.3 ± 21.8	74.4 ± 21.3	0.047
Social	51.2 ± 32.1	62.5 ± 29.1	0.01	51.5 ± 28.9	63.7 ± 31.5	0.005	52.8 ± 29.9	62.8 ± 31.0	0.021
Symptom scale									
Fatigue	52.8 ± 28.7	44.2 ± 24.7	0.024	52.6 ± 25.7	43.1 ± 27.0	0.012	53.9 ± 26.9	41.5 ± 25.2	0.001
Pain	43.8 ± 30.7	32.5 ± 30.8	0.011	43.0 ± 31.8	31.7 ± 29.7	0.01	44.6 ± 31.7	29.8 ± 29.0	0.001

P values were driven from t tests. – means insignificant P values (> 0.05).

Abbreviations: EORTC QLQ-C30, the European Organization for Research and Treatment of Cancer quality of life questionnaire core-30.

Global health status/Quality of life scale of the EORTC QLQ-C30 reflects overall health and quality of life by one single last item.

Summary score of the EORTC QLQ-C30 was based on the sum of all scales of the QLQ-C30, excluding the scale for financial difficulties and global health status.

EORTC QLQ-C30	Albumin (g/dL)		P-value	Creatinine (mg/dL)		P-value	Uric acid (mg/dL)		P-value
Dyspnea	39.3 ± 34.4	28.2 ± 29.4	0.018	30.6 ± 31.6	35.0 ± 32.3	-	34.3 ± 32.1	31.3 ± 31.9	-
Insomnia	40.5 ± 35.1	35.1 ± 31.0	-	42.9 ± 34.5	32.0 ± 30.4	0.019	42.6 ± 33.7	32.0 ± 31.2	0.022
Appetite loss	51.2 ± 34.5	43.7 ± 33.6	-	46.3 ± 35.1	47.4 ± 33.3	-	48.8 ± 33.5	44.8 ± 34.7	-
Constipation	30.2 ± 33.8	25.0 ± 32.0	-	26.5 ± 31.7	27.8 ± 33.9	-	31.0 ± 33.4	23.2 ± 31.7	-
Diarrhea	9.5 ± 19.1	12.6 ± 23.9	-	13.3 ± 21.8	9.5 ± 22.2	-	12.2 ± 23.4	10.4 ± 20.6	-
Financial difficulties	34.9 ± 31.4	34.2 ± 33.3	-	37.1 ± 31.7	32.0 ± 33.1	-	39.9 ± 31.6	29.0 ± 32.5	0.016
Global health status	45.1 ± 19.1	50.0 ± 21.2	-	47.5 ± 20.5	48.4 ± 20.4	-	46.1 ± 18.1	49.8 ± 22.5	-
Summary score	61.5 ± 19.1	69.0 ± 16.6	0.004	62.9 ± 18.5	68.7 ± 17.2	0.023	61.8 ± 17.8	70.0 ± 17.4	0.001

P values were driven from t tests. – means insignificant P values (> 0.05).

Abbreviations: EORTC QLQ-C30, the European Organization for Research and Treatment of Cancer quality of life questionnaire core-30.

Global health status/Quality of life scale of the EORTC QLQ-C30 reflects overall health and quality of life by one single last item.

Summary score of the EORTC QLQ-C30 was based on the sum of all scales of the QLQ-C30, excluding the scale for financial difficulties and global health status.

Table 4
A Generalized Linear Model of Summary Score in EORTC QLQ-C30 and Mid-upper Arm Circumference Group Adjusted by Nutritional Markers (n = 193)

Variable	Beta	Standard Error	P-value
Creatinine(mg/dL)	0.014	0.023	0.536
Uric Acid(mg/dL)	0.011	0.0105	0.308
Albumin(mg/dL)	0.139	0.0396	<0.001
Upper MUAC group	0.085	0.0398	0.033
Lower MUAC group	referent		

Abbreviations: MUAC, Mid-upper arm circumference; EORTC QLQ-C30, the European Organization for Research and Treatment of Cancer quality of life questionnaire core-30.

Discussion

The main finding of this study was a significant positive association between MUAC and QOL. We found that summary score, the sum of all symptom and function scores of QOL, was significantly better in the higher MUAC group (≥ 26.5 cm). Our study also proved that albumin had a proportionate relationship with QOL. Namely, having a higher level of albumin was positively associated with a better summary score. Our results suggest that a simple and easy method of MUAC can be a useful measurement to reflect QOL in patients with advanced cancer. This finding is consistent with a previous study demonstrating a positive association between better nutritional value and higher QOL in palliative care [13]. The authors of that study showed that nutritional care could improve QOL by minimizing symptoms such as nausea and vomiting [13]. This result has been reproduced in a study of Nguyen et al., showing a positive correlation between nutritional improvement status and better QOL of patients with gastrointestinal cancer [18]. That study highlights that nutritional diet intervention can significantly benefit the QOL of patients with gastrointestinal cancer. Consistent with previous studies, the association between MUAC and summary score can be explained by the nutritional status of advanced cancer patients as follows.

Preceding studies have repeatedly reported a strong association between low MUAC and muscle loss [7, 22]. The majority of cancer patients go through involuntary weight loss and muscle wasting due to CACS, leading to lower MUAC. Such condition can lead to higher susceptibility of patients to pain, fatigue, and functional decline [8]. These domains are summed up as a summary score in our study. Fatigue is one of the most noticeable symptoms due to muscle loss that can lead to deterioration of performance status [3]. Fatigue is known to be an index of reduction in anthropometric measurements in patients with advanced cancer [20]. On the other hand, it is notable that weight and muscle losses can worsen the pain [5]. Obviously, such symptoms can be reflected in the summary score. Other functional scales also

contribute to the summary score. Thus, we assume that the mechanism involved in weight and muscle losses lie behind the relationship between MUAC and QOL in patients with advanced cancer.

Higher serum albumin (≥ 3.7 g/dL) was also independently associated with better summary score of EORTC QLQC-30 in the current study. Albumin level is known as one of the most important nutritional indices in patients with advanced cancer [12]. Our findings confirm the correlation of albumin with body cell mass (BCM). Systemic inflammatory response (SIR) is a widely accepted mechanism behind low albumin related to sarcopenia due to CACS [11]. Patients having cachexic condition with hypoalbuminemia might suffer from various symptom burden and lower function that can result in lower summary score.

Arrieta et al. have demonstrated that albumin synthesis diminishes with systemic inflammatory response (SIR) [2]. Notably, hypoalbuminemia is significantly related to poor prognosis and lower QOL through SIR in patients with advanced cancer[14, 15] Our findings suggest that nutritional intervention to keep albumin level and MUAC range would be needed to enhance QOL in patients with advanced cancer. This may imply the need of using MUAC to monitor QOL and nutritional status.

Strengths of our study are as follows. First, we demonstrated MUAC as a novel marker to reflect QOL in patients with advanced cancer. MUAC is a useful tool attributed to its non-invasive and easily applicable nature. Even after disease progresses, MUAC can be evaluated in a bed-ridden state when it is difficult to measure body weight directly. Second, our study population consisted of ambulatory patients with various cancer types based on oncologists' prediction of one-year survival. These patients usually suffer from CACS. However, appropriate anthropometric measurements can be omitted due to some reasons. Third, our study findings included diverse data from laboratory test and anthropometric measurements as well as questionnaire. Such data can be baseline parameters for providing QOL intervention and nutrition in future.

This study has some limitations that warrant discussion. First, this was a single center study. Therefore, it might be limited in terms of generalization. Second, measurement of MUAC might need training beforehand. Third, owing to the natural measuring limitation of MUAC, differentiating specific composition of fat or muscle mass was not possible. Fourth, MUAC reference values change with age and gender. Future studies are needed to specify reference values of MUAC.

Conclusion

In conclusion, MUAC had a significant relationship with QOL of patients with advanced cancer. Our findings suggest that MUAC is a simple anthropometric assessment to monitor QOL for possible intervention.

Declarations

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Conflicts of interest/Competing interests:

The authors have no conflicts of interest to disclose.

Data availability:

The data of this study are available from the corresponding author, Sang-Yeon Suh, upon reasonable request. All authors agreed to the journal to review the data upon necessity.

Code availability

Not applicable.

Authors' contributions:

Seon-Hye Won: Preliminary analysis, Investigation, Methodology, Writing – original draft, Writing – review and editing

Yusuke Hiratsuka: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review and editing

Sang-Yeon Suh: Conceptualization, Investigation, Methodology, Project implementation, Supervision, Writing – review and editing

Hayoung Bae: Preliminary analysis, Formal analysis, Methodology, Writing – review and editing

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Jin Won Kim: Investigation, Writing – review and editing

Keun-Wook Lee: Investigation, Writing – review and editing

Ethics approval:

The protocol was approved by the Institutional Review Board (IRB) of Seoul National University Bundang Hospital (IRB number: B-1601/332-302).

Consent to participate:

Informed consent was waived due to its retrograde nature and minimal risk of the study nature by our institutional review board

Consent for publication:

Not applicable.

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References

1. Aaronson NK, Ahmedzai S, Bergman B, Bullinger M, Cull A, Duez NJ, Filiberti A, Flechtner H, Fleishman SB, de Haes JC, et al. (1993) The European Organization for Research and Treatment of Cancer QLQ-C30: a quality-of-life instrument for use in international clinical trials in oncology J Natl Cancer Inst 85: 365-376
2. Arrieta O, Michel Ortega RM, Villanueva-Rodríguez G, Serna-Thomé MG, Flores-Estrada D, Diaz-Romero C, Rodríguez CM, Martínez L, Sánchez-Lara K (2010) Association of nutritional status and serum albumin levels with development of toxicity in patients with advanced non-small cell lung cancer treated with paclitaxel-cisplatin chemotherapy: a prospective study BMC Cancer 10: 50
3. Bower JE (2014) Cancer-related fatigue–mechanisms, risk factors, and treatments Nat Rev Clin Oncol 11: 597-609
4. Bruera E (1997) ABC of palliative care. Anorexia, cachexia, and nutrition Bmj 315: 1219-1222
5. Chiba T, Takahashi H, Tairabune T, Kimura S, Ueda H, Kudo K (2020) Cancer Cachexia May Hinder Pain Control When Using Fentanyl Patch Biological and Pharmaceutical Bulletin 43: 873-878
6. Evans DC, Corkins MR, Malone A, Miller S, Mogensen KM, Guenter P, Jensen GL (2021) The Use of Visceral Proteins as Nutrition Markers: An ASPEN Position Paper Nutr Clin Pract 36: 22-28
7. Griffiths RD (1996) Muscle mass, survival, and the elderly ICU patient Nutrition 12: 456-458
8. Kyle UG, Genton L, Hans D, Karsegard VL, Michel JP, Slosman DO, Pichard C (2001) Total body mass, fat mass, fat-free mass, and skeletal muscle in older people: cross-sectional differences in 60-year-old persons J Am Geriatr Soc 49: 1633-1640

9. Laky B, Janda M, Kondalsamy-Chennakesavan S, Cleghorn G, Obermair A (2010) Pretreatment malnutrition and quality of life - association with prolonged length of hospital stay among patients with gynecological cancer: a cohort study BMC Cancer 10: 232
10. Lang IA, Llewellyn DJ, Alexander K, Melzer D (2008) Obesity, physical function, and mortality in older adults J Am Geriatr Soc 56: 1474-1478
11. Lin J, Zhang W, Huang Y, Chen W, Wu R, Chen X, Lou N, Wang P (2018) Sarcopenia is associated with the neutrophil/lymphocyte and platelet/lymphocyte ratios in operable gastric cancer patients: a prospective study Cancer Management and Research Volume 10: 4935-4944
12. Margarson MP, Soni N (1998) Serum albumin: touchstone or totem? Anaesthesia 53: 789-803
13. Marín Caro MM, Laviano A, Pichard C (2007) Nutritional intervention and quality of life in adult oncology patients Clin Nutr 26: 289-301
14. McMillan DC (2008) An inflammation-based prognostic score and its role in the nutrition-based management of patients with cancer Proc Nutr Soc 67: 257-262
15. McMillan DC (2009) Systemic inflammation, nutritional status and survival in patients with cancer Curr Opin Clin Nutr Metab Care 12: 223-226
16. McMillan DC, Forrest LM, O'Gorman P, Angerson WJ, McArdle CS (2002) Performance status of male and female advanced cancer patients is independently predicted by mid-upper arm circumference measurement Nutr Cancer 42: 191-193
17. Nayak MG, George A, Vidyasagar MS, Mathew S, Nayak S, Nayak BS, Shashidhara YN, Kamath A (2017) Quality of Life among Cancer Patients Indian J Palliat Care 23: 445-450
18. Nguyen LT, Dang AK, Duong PT, Phan HBT, Pham CTT, Nguyen ATL, Le HT (2021) Nutrition intervention is beneficial to the quality of life of patients with gastrointestinal cancer undergoing chemotherapy in Vietnam Cancer Med 10: 1668-1680
19. Salas S, Mercier S, Moheng B, Olivet S, Garcia ME, Hamon S, Sibertin-Blanc C, Duffaud F, Auquier P, Baumstarck K (2017) Nutritional status and quality of life of cancer patients needing exclusive chemotherapy: a longitudinal study Health Qual Life Outcomes 15: 85
20. Schulz K-H, Patra S, Spielmann H, Klapdor S, Schlüter K, Van Eckert S (2017) Physical condition, nutritional status, fatigue, and quality of life in oncological out-patients SAGE Open Medicine 5: 205031211774367
21. Tsai HJ, Chang FK (2017) Associations between body mass index, mid-arm circumference, calf circumference, and functional ability over time in an elderly Taiwanese population PLoS One 12: e0175062
22. Wannamethee SG, Shaper AG, Lennon L, Whincup PH (2007) Decreased muscle mass and increased central adiposity are independently related to mortality in older men Am J Clin Nutr 86: 1339-1346
23. Woo J, Ho SC, Sham A (2001) Longitudinal changes in body mass index and body composition over 3 years and relationship to health outcomes in Hong Kong Chinese age 70 and older J Am Geriatr Soc 49: 737-746