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

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Abstract

Objective: 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/m², p < 0.001), higher serum albumin (≥ 3.7 g/dL, p < 0.01), higher creatinine (≥ 0.8 mg/dL, p = 0.023), and higher uric acid (≥ 5 mg/dL, p < 0.01). 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.

Keywords
Mid-upper arm circumference, nutritional marker, advanced cancer, European organization for research and treatment of cancer quality of life questionnaire core30 (EORTC QLQ-C30)

Introduction

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 quality of life (QOL). In patients with far advanced cancer, enhancing QOL is the main goal of care and a priority for patients themselves. 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. Nutritional markers have been reported to be related to 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. On the other hand, body mass index (BMI) plays a classical role in

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assessing QOL as an easily accessible tool in clinical practice. Mid-upper arm circumference (MUAC) has also been used as a simple and practical measure of nutrition for a long time. Previous studies have demonstrated that MUAC can be an efficient tool to assess health status, disability, and mortality in the elderly.6,7 A few studies have showed the relationship between MUAC and malnutrition or mortality among cancer patients.8,9 However, further studies on the association between MUAC and QOL in patients with advanced cancer are scanty.

Among anthropometric measurements, 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.

**Methods**

**Study Design**

This was a cross-sectional, single-center study.

**Setting and Participants**

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.

**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.10 In this QOL questionnaire, scales for physical, emotional, cognitive, and social functioning and for global QOL 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 QOL), 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 QOL 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 (BUN), creatinine) were collected from electronic medical records. Regarding assessment, the research nurse has been trained properly to measure MUAC. 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 electronic 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. Since BMI is closely related to MUAC statistically, we excluded BMI in analysis. 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).

**Ethical Considerations**

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).

**Results**

A total of 200 patients with advanced cancer from March 2016 to January 2019 were enrolled (Table 1). 7 patients rejected to additional measurements and were therefore excluded. The mean patient age was 64.5 ± 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%),
Table 1. Characteristics of Enrolled Patients (n = 193).

| Characteristics                        | n (%)          |
|----------------------------------------|----------------|
| Age (years, mean ± SD)                 | 64.3 ± 11.5    |
| Gender                                 |                |
| Male                                   | 123 (63.7)     |
| Female                                 | 70 (36.3)      |
| Primary cancer site                    |                |
| Lung                                   | 73 (37.8)      |
| Stomach                                | 33 (17.1)      |
| Colon/Rectal                           | 2 (1.0)        |
| Liver/Biliary-tract                    | 6 (3.1)        |
| Pancreas                               | 2 (1.0)        |
| Esophagus                              | 6 (3.1)        |
| Head/Neck                              | 4 (2.1)        |
| Soft tissue                            | 6 (3.1)        |
| Kidney/Bladder                         | 26 (13.5)      |
| Others                                 | 40 (20.7)      |
| Undergoing chemotherapy (Yes)          | 125 (64.8)     |
| ECOG performance status                |                |
| 0                                      | 8 (4.1)        |
| 1                                      | 120 (62.2)     |
| 2                                      | 53 (27.5)      |
| 3                                      | 12 (6.2)       |
| 4                                      | 0 (0)          |
| EORTC QLQ-C30 Score (mean ± SD)        |                |
| Functional scales                      |                |
| Physical                               | 57.2 ± 23.5    |
| Role                                   | 52.7 ± 30.0    |
| Emotional                              | 74.0 ± 22.0    |
| Cognitive                              | 71.0 ± 22.0    |
| Social                                 | 57.7 ± 31.0    |
| Symptom scale                          |                |
| Fatigue                                | 47.8 ± 26.8    |
| Nausea and vomiting                    | 17.2 ± 23.9    |
| Pain                                   | 37.7 ± 32.4    |
| Dyspnea                                | 32.8 ± 32.0    |
| Insomnia                               | 38.0 ± 32.9    |
| Appetite loss                          | 46.6 ± 34.4    |
| Constipation                           | 26.8 ± 32.5    |
| Diarrhoea                              | 11.2 ± 21.9    |
| Financial difficulties                 | 34.7 ± 32.6    |
| Global health status                   | 48.6 ± 20.2    |
| Summary score                          | 65.7 ± 18.3    |
| Laboratory test results (mean ± SD)    |                |
| Hemoglobin (g/dL)                      | 11.1 ± 1.9     |
| Lymphocyte (%)                         | 22.1 ± 10.9    |
| Albumin (mg/dL)                        | 38.9 ± 53.3    |
| ALT (IU/L)                             | 28.1 ± 33.4    |
| 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)                 | 161.5 ± 8.1    |
| Weight (kg, mean ± SD)                 | 58.8 ± 12.4    |
| BMI (mean ± SD)                        | 22.5 ± 4.0     |

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.

Discussion

The main finding of this study was a significant positive association between MUAC and QOL. Namely, summary score, the sum of all symptom and function scores of QOL, was significantly better in the higher MUAC group (≥26.5 cm). The higher MUAC group also had better self-rating overall health status. This is consistent with previous study which showed the positive relationship between MUAC and QOL in cancer patients. As a simple and easy method, MUAC can be a useful measurement to reflect QOL in patients with advanced cancer.

The association between MUAC and summary score can be explained by the nutritional status of advanced cancer patients. Preceding studies have repeatedly reported a strong association between low MUAC and muscle loss. 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. 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. On the other hand, it is notable that body weight and muscle losses can worsen the pain. Obviously, such symptoms can be reflected in the summary score. Other functional scales also contribute to the summary score. Thus, the mechanism involved in weight and muscle losses lie behind the relationship between MUAC and QOL in patients with advanced cancer. Eventually, symptom burden and functional status affected overall health status perceived by patients themselves.

Our finding is consistent with a previous study demonstrating a positive association between better nutritional parameters and higher QOL in palliative care. The study showed that supportive intervention on nutritional status could improve QOL by minimizing symptoms such as nausea and vomiting. 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.
con CACS.24 Patients having cachexic condition with hypoalbuminemia mechanism behind low albumin related to sarcopenia due to cancer.21 Our study also proved that albumin had a proportionally important nutritional indices in patients with advanced cancer.27 Due to CACS, reduced muscle mass limits generation and storage of creatinine. As a result, lower creatinine level could lead to worse QOL through poor immune function, and even shortened survival of patients with advanced cancer.28,29

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      | 101             | 92      |         |

Functional scale

|                   | Physical                       | Role                | Emotional                  | Cognitive       | Social            |
|-------------------|-------------------------------|---------------------|---------------------------|-----------------|-------------------|
| P-value           | 0.001                         | < 0.001             | -                         | 0.002           | 0.001             |
| Score             | 51.4 ± 24.3                   | 62.8 ± 21.3         | 73.7 ± 22.3               | 74.2 ± 21.8     | 66.0 ± 23.6       |

Symptom scale

|                   | Fatigue                       | Pain                | Dyspnea                   | Insomnia        | Appetite loss    |
|-------------------|-------------------------------|---------------------|---------------------------|-----------------|-----------------|
| P-value           | 0.001                         | 0.014               | -                         | 0.021           | 0.013           |
| Score             | 54.5 ± 26.4                   | 43.4 ± 31.1         | 34.8 ± 32.4               | 42.2 ± 35.0     | 52.5 ± 36.1     |

Global health status

|                   | Constipation                   | Diarrhea            | Financial difficulties    | Global health status   |
|-------------------|-------------------------------|---------------------|---------------------------|------------------------|
| P-value           | 0.003                         | 0.013               | 0.013                     | 0.002                  |
| Score             | 27.3 ± 32.4                   | 13.5 ± 23.6         | 33.3 ± 30.5               | 44.1 ± 20.1           |

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 of patients with advanced cancer.25 These patients usually suffer from CACS. However, appropriate anthropometric measurements can be omitted due to some reasons. Third, 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
Summary score of the EORTC QLQ-C30 was based on the sum of all scales of the QLQ-C30, excluding the scale for goal of patients with advanced cancer. In conclusion, our enhancing and preserving the best possible QOL is the main conclusion. Future studies are needed to specify reference values 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.

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            | 82            | 111     | 97                | 96      | 98              | 95      |
| Functional scale |               |         |                   |         |                 |         |
| Physical     | 50.7 ± 25.5   | 62.0 ± 20.6 | <0.001            | 55.1 ± 24.4 | 59.4 ± 22.4 | -       |
| Role         | 45.5 ± 31.2   | 58.0 ± 28.0 | 0.004             | 49.0 ± 29.7 | 56.4 ± 29.9 | -       |
| Emotional    | 73.4 ± 20.9   | 74.4 ± 22.9 | -                | 70.9 ± 23.0 | 77.1 ± 20.5 | -       |
| Cognitive    | 67.3 ± 23.0   | 73.7 ± 20.9 | -                | 68.2 ± 23.3 | 73.8 ± 20.2 | -       |
| Social       | 51.0 ± 32.2   | 62.6 ± 29.2 | 0.010            | 51.7 ± 29.0 | 63.7 ± 32.0 | 0.007   |
| Symptom scale |               |         |                   |         |                 |         |
| Fatigue      | 53.3 ± 28.9   | 43.8 ± 24.5 | 0.016             | 52.8 ± 25.7 | 42.8 ± 27.1 | 0.009   |
| Pain         | 44.1 ± 31.0   | 33.0 ± 31.2 | 0.016             | 43.1 ± 32.3 | 32.0 ± 30.3 | 0.017   |
| Dyspnea      | 39.8 ± 34.5   | 27.6 ± 29.8 | 0.009             | 30.6 ± 31.8 | 35.1 ± 32.9 | -       |
| Insomnia     | 41.1 ± 35.3   | 35.7 ± 31.0 | -                | 43.0 ± 34.7 | 33.0 ± 30.4 | 0.035   |
| Appetite loss| 51.6 ± 34.8   | 42.9 ± 33.8 | -                | 46.4 ± 35.2 | 46.9 ± 33.7 | -       |
| Constipation | 30.5 ± 34.0   | 24.0 ± 31.2 | -                | 26.8 ± 31.8 | 26.7 ± 33.4 | -       |
| Diarrhea     | 9.3 ± 19.1    | 12.6 ± 23.8 | -                | 13.1 ± 21.8 | 9.4 ± 22.2  | -       |
| Financial difficulties | 3.46 ± 3.16 | 3.48 ± 3.35 | -                | 3.68 ± 3.17 | 3.26 ± 3.35 | -       |
| Global health status | 45.1 ± 19.3 | 51.2 ± 20.6 | -                | 47.5 ± 20.6 | 49.7 ± 19.9 | -       |
| Summary score | 61.3 ± 19.3  | 69.0 ± 16.8 | 0.003            | 62.9 ± 18.6 | 68.6 ± 17.5 | 0.029   |

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.

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
Enhancing and preserving the best possible QOL is the main goal of patients with advanced cancer. In conclusion, our study showed that MUAC had a significant relationship with QOL of patients with advanced cancer in terms of summary score and overall health status. Our findings suggest that MUAC is a simple but easy anthropometric assessment to monitor QOL for possible intervention.

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

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