Chapter 6

The influence of different muscle mass measurements on the diagnosis of cancer cachexia

Susanne Blauwhoff-Buskermolen
Jacqueline A.E. Langius
Annemarie Becker
Henk M.W. Verheul
Marian A.E. de van der Schueren

Submitted
Abstract

Background: Progressive loss of muscle mass is a major characteristic of cancer cachexia. Consensus definitions for cachexia provide different options to measure muscle mass. This study describes the effect of different methods to determine muscle mass on the diagnosis of cancer cachexia. In addition, the association of cachexia with other features of cachexia, quality of life and survival was explored.

Methods: Prior to chemotherapy, cachexia was assessed by weight loss (WL), BMI and muscle mass measurements, the latter by Mid Upper Arm Muscle Area (MUAMA), Computed Tomography (CT) scans and Bio-Electrical Impedance Analysis (BIA). In addition, appetite, inflammation, muscle strength, fatigue, quality of life and survival were measured and associations with cachexia were explored.

Results: Included were 241 patients with advanced cancer of the lung (36%), colon/rectum (31%), prostate (18%) or breast (15%). Mean age was 64±10 years, 54% was male. Prevalence of low muscle mass was: 13% with MUAMA, 59% with CT and 93% with BIA. In turn, the prevalence of cachexia was 37%, 43% and 48%, whereby WL >5% was the most prominent component of being defined cachectic. Irrespective of type of muscle measurement, patients with cachexia presented more often with anorexia, inflammation, low muscle strength and fatigue and had lower quality of life. Patients with cachexia had worse overall survival compared to patients without cachexia: HRs 2.00 (1.42-2.83) with MUAMA, 1.64 (1.15-2.34) with CT, and 1.50 (1.05-2.14) with BIA.

Conclusions: Although the prevalence of low muscle mass in patients with cancer depended largely on the type of muscle measurement, this had little influence on the diagnosis of cancer cachexia (as the majority of patients was already defined cachectic based on weight loss). New studies are warranted to further elucidate the additional role of muscle measurements in the diagnosis of cachexia and the association with clinical outcomes.
Introduction

Cachexia is a clinically relevant syndrome in cancer and is associated with reduced tolerance to anticancer therapy, reduced quality of life and reduced survival (1-4). In ancient times, Hippocrates described cachexia as “the flesh is consumed and becomes water,... the abdomen fills with water; the feet and legs swell, the shoulders, clavicles, chest and thighs melt away…” (5). Recently, cachexia has been defined as ‘a complex metabolic syndrome associated with underlying illness and characterized by loss of muscle with or without loss of fat mass’ (6). Other features of cachexia are chronic inflammation, poor appetite, decreased muscle strength and fatigue (7,8).

Cachexia is often underestimated for several reasons, for example the high prevalence of overweight. In a study of Kyle et al, excess fat mass reduced the sensitivity of BMI to detect nutritional depletion in a general hospital population (9). In a study by Sun et al cachexia was underestimated by oncologists in 77% of the patients, mainly due to good performance status and normal BMIs of the patients (10).

A uniform framework to identify patients with cachexia might be helpful for decision making on supportive treatment in patient care, and for research, to be able to compare clinical trials. In 2011, a consensus definition and diagnostic framework for cancer cachexia has been put forward with accompanying cut-off values for weight loss, body mass index and low muscle mass (6). This framework provides four different options to measure muscle mass: dual energy x-ray imaging (DEXA), computed tomography (CT) or magnetic resonance imaging (MRI), bioelectrical impedance analysis (BIA) and mid-upper arm muscle area (MUAMA). It is unknown if, and to what extent, the choice for type of muscle measurement affects the diagnosis of cancer cachexia. As DEXA, CT and MRI are primarily being used in research and BIA and MUAMA in clinical practice, it would be helpful to know whether the measurements are interchangeable in the diagnosis of cancer cachexia. Therefore, the aim of the present study was to detect whether different measures of muscle mass affect the diagnosis of cancer cachexia. A second aim was to explore the association between cachexia (with different muscle measurements) and other features of cachexia, quality of life and survival in patients with advanced cancer.
Subjects and Methods

Patients aged 18 years or older with advanced prostate, lung, breast or colorectal cancer who were scheduled for palliative chemotherapy treatment at the Departments of Medical Oncology or Pulmonology of the VU University Medical Center Amsterdam were invited to enter the study. Systemic treatment in the past month, clinically overt ascites or serious pitting edema and missing values for one of the muscle measurements were exclusion criteria. The research protocol was approved by the Medical Ethics Committee of the VU University Medical Center Amsterdam and registered in the Netherlands National Trial Register under number NTR3094. The study was performed in accordance with the ethical standards laid down in the Declaration of Helsinki of 1975 as revised in 1983 and written informed consent was obtained from all participants.

Study design

In this observational study, features of cachexia: weight loss, muscle mass, appetite, inflammation, hand grip strength and fatigue were determined prior to chemotherapy according to the methods described below. Furthermore, data on WHO performance status (11), comorbidity (Charlson Comorbidity Index) (12) and treatment line (counted as consecutive treatment line) were obtained from the medical records.

Cancer cachexia

Weight and height

Body weight was measured (with patients wearing light indoor clothes without shoes) within 0.2 kg on a calibrated scale (Seca type 888). Self-reported weight from 6 months before inclusion was assessed in order to calculate percentage weight loss. A correction factor for clothes or clothes and shoes was made by deducting weight with respectively 1.6 and 2.0 kilograms for men and 1.0 and 1.3 kilograms for women (13). Body mass index (BMI) was calculated as the ratio of body weight (kg)/height (m)^2.

Muscle mass

Three different muscle measurements were used in the diagnostic framework of cancer cachexia to detect low skeletal muscle: MUAMA, CT scans and BIA.
Muscle mass in diagnostic criteria of cachexia

Mid-upper arm muscle area (MUAMA)

Mid-upper arm circumference (MUAC) was measured two times at the midpoint of the non-dominant upper arm between the acromion process and the tip of the olecranon process, using a tape measure. To calculate the mid-arm muscle circumference, the triceps skin fold (TSF) was measured two times by a trained dietician at the same point using a John Bull skin fold caliper (British Indicators, Ltd., West Sussex, UK). The mean value of these measurements was recorded. Mid-upper arm muscle circumference (MUAMC) was calculated as follows: MUAC-(π*TSF). Corrected Mid-arm muscle area in mm (MUAMA) was calculated as follows: MUAMC*MUAMC)/100) / (4* π) minus 10.0 for males and minus 6.5 for females (14).

Skeletal muscle by CT

Skeletal muscle area (cm\(^2\)) was measured with SliceOmatic Software V 5.0 (Tomovision, Magog, Canada) using routine CT scans conducted for diagnostic purposes. The third lumbar vertebra (L3) was used as a standard landmark (15); the first image extending from L3 to the iliac crest was chosen to measure total muscle cross-sectional area. The L3 region contains psoas, paraspinal muscles, and the abdominal wall muscles. In patients with lung cancer abdominal CT-images were not available, therefore the fourth thoracic vertebra (T4) was used for the assessment of the skeletal muscle area. T4 contains pectoralis muscles, external intercostal, serratus anterior, teres major, subscapularis, infraspinatus, rhomboid major, erector spinae and trapezius muscles. The structures of the specific muscles were quantified based on pre-established thresholds of Hounsfield Units (HU) (-29 to + 150) of muscle tissue (16).

Cross-sectional areas (cm\(^2\)) of the sum of all these muscles were computed by summing tissue pixels and multiplying by the pixel surface area for each patient. Skeletal Muscle Index (SMI) was calculated as the ratio of skeletal muscle area (cm\(^2\))/height (m)\(^2\).

FFMI by BIA

FFMI was determined using a bioelectrical impedance analyzer (Quadscan, Bodystat, Douglas, Isle of Men, United Kingdom). The measurements were performed prior to chemotherapy, before infusion with fluids, with the patient in supine position. Two current electrodes (Bodystat Electrodes, Bodystat) were placed at the right side at the clean dorsal surfaces of hand and foot on the distal portion of the second
metacarpal and metatarsal, respectively. Two detector electrodes were placed at the posterior wrist between the styloid processes of the radius and ulna and at the anterior ankle between the tibial and fibular malleoli. FFMI was calculated as: \[ \text{FFMI} = \frac{\text{height}^2}{\text{BIA-resistance at 50 kHz} \times 0.401} + \text{gender} \times 3.825 + \text{age} \times 0.071 + 5.102 \] (17).

**Diagnosis of cachexia**

Cachexia was defined applying the diagnostic framework of Fearon et al (6):

- Unintentional weight loss >5% in the previous 6 months OR
- Weight loss >2% in 6 months in combination with BMI <20 kg/m\(^2\) OR
- Weight loss >2% in 6 months in combination with low muscle mass:
  - MUAMA: men <32 cm\(^2\), women <18 cm\(^2\) (6)
  - CT: SMI < reference (L3: <55 cm\(^2\)/m\(^2\) for males, <39 cm\(^2\)/m\(^2\) for females (6), T4: <66.0 cm\(^2\)/m\(^2\) for males, <51.9 cm\(^2\)/m\(^2\) for females)*
  - BIA: FFMI without bone: men <14.6 kg/m\(^2\), women <11.4 kg/m\(^2\) (6)

*Cut-off values of muscle mass at T4 level for CT scans have not been provided by the consensus paper (6). The cut-off values presented are based on a study where patients had SMI data on both L3 and T4 level; T4 cut-off values are based on the validated L3 cut-off value (data not published).

**Cachexia features**

Patients with cachexia present often with other features such as anorexia, inflammation, low hand grip strength and fatigue. The methods of these measurements are described below.

**Anorexia**

Patients filled out two appetite questionnaires: The FAACT–A/CS (4\(^{th}\) version, Dutch) (18) and the visual analogue scale (VAS) for appetite. Based on previous research, poor appetite was defined as a score \(<37\) on the FAACT-A/CS questionnaire or \(<70\) on the VAS for appetite (19).

**Inflammation**

Plasma concentrations of C-reactive protein (CRP) were measured with an automated latex-enhanced immunoturbidimetric assay on a Modular P analyzer (Roche Diagnostics, Almere, The Netherlands) (20). Inflammation was defined
as a plasma CRP concentration of ≥8 mg/L (upper limit of normality of the VU University Medical Center).

**Low hand grip strength**
Hand grip strength was measured using a hydraulic hand dynamometer (Baseline, Fabrication Enterprises, New York). The test was performed sitting with the elbow flexed at 90°, forearm and wrist in neutral position. Patients were instructed to perform 2 maximal isometric contractions with the right hand. Maximal values were recorded to the nearest 0.5 kg, and the mean of the measurements was used. Grip strength below the 5th percentile of healthy adults (21) was regarded as low hand grip strength.

**Fatigue**
Patients filled out the Functional Assessment of Chronic Illness Therapy-Fatigue (FACIT-F) questionnaire, a questionnaire with 13 items that measures an individual’s level of fatigue during their usual daily activities over the past week. The level of fatigue is measured on a four point Likert scale, resulting in a total score between 0-52 with a lower score indicating more fatigue (22).

**Quality of life**
Patients filled out the European Organization for Research and Treatment of Cancer – Quality of Life Questionnaire C30 (EORTC-QLQC30) questionnaire, a multidimensional validated cancer-specific questionnaire that includes global quality of life and subdomains of physical functioning, role functioning, emotional functioning, cognitive functioning and social functioning. EORTC-QLQC30 subscales were calculated according to the EORTC-QLQC30 manual and vary from 0 to 100. A high score for a functional or quality of life scale represents a high level of functioning or quality of life (23,24).

**Survival**
A year after the last patient had been included, survival data were obtained from the electronic medical record of each patient. Survival time was defined as time from inclusion in the study until death. Patient who were still alive were censored at date of last consultation in the hospital or with general practitioner.
Statistical analyses

Statistical analyses were performed using SPSS for Windows version 22 (IBM Corporation, Armonk, NY, USA). Descriptive statistics (count (%), means ± SD, or median and interquartile ranges, as appropriate) were used to describe the study sample regarding patient characteristics and prevalence of low muscle mass and cachexia.

To assess differences in cachexia features and quality of life between patients with and without cachexia based on different muscle measurements, independent t-tests were used for normal distributed variables (global quality of life and fatigue), Mann Whitney analyses for not normal distributed variables (VAS anorexia, FAACT-A/CS, CRP, physical functioning, role functioning, emotional functioning, cognitive functioning and social functioning) and Chi² tests for categorical variables (anorexia, inflammation and WHO performance score).

Cox proportional hazards analyses were performed to test associations between overall survival and cachexia (with MUAMA for muscle, CT for muscle and BIA for muscle respectively) in patients with stage IV cancer. In multiple regression analyses, adjustments were made for age, sex, cancer type, treatment line (≥2nd versus 1st) and comorbidity (CCI ≥ 1 versus 0). A p-value of ≤ 0.05 was considered significant for all analyses.

Results

Patients

Three-hundred and sixty-four patients were invited to participate in this study of which 241 were eligible and willing to participate (figure 1).

![Flowchart](figure1.png)

Figure 1. Flowchart
Mean age was 64±10 years, 54% was male and the patients were diagnosed with stage III-IV lung cancer (n=87, 36%), stage IV colon/rectal cancer (n=76, 31%), stage IV prostate cancer (n=43, 18%) or stage IV breast cancer (n=36, 15%). The majority of patients (79%) was planned to receive first line therapy (table 1).

Table 1. Patient characteristics (n=241)

<table>
<thead>
<tr>
<th></th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (male)</td>
<td>130 (54)</td>
</tr>
<tr>
<td>Age (years)*</td>
<td>64±10</td>
</tr>
<tr>
<td>Cancer site</td>
<td></td>
</tr>
<tr>
<td>Colorectal</td>
<td>76 (31)</td>
</tr>
<tr>
<td>Lung</td>
<td>86 (36)</td>
</tr>
<tr>
<td>NSCLC stage III</td>
<td>29 (12)</td>
</tr>
<tr>
<td>NSCLC stage IV</td>
<td>47 (19)</td>
</tr>
<tr>
<td>SCLC LD</td>
<td>4 (2)</td>
</tr>
<tr>
<td>SCLC ED</td>
<td>6 (3)</td>
</tr>
<tr>
<td>Breast</td>
<td>36 (15)</td>
</tr>
<tr>
<td>Prostate</td>
<td>43 (18)</td>
</tr>
<tr>
<td>Treatment line</td>
<td></td>
</tr>
<tr>
<td>1st</td>
<td>190 (79)</td>
</tr>
<tr>
<td>2nd</td>
<td>31 (13)</td>
</tr>
<tr>
<td>Higher than 2nd</td>
<td>20 (8)</td>
</tr>
<tr>
<td>Surgery in past 6 months</td>
<td>37 (15)</td>
</tr>
</tbody>
</table>

Abbreviations: NSCLC: non small cell lung cancer; SCLC: small cell lung cancer; LD: limited disease; ED: extensive disease

*mean±sd

Prevalence of low muscle mass and cachexia

Low muscle mass was prevalent in 13% of patients (n=32) according to MUAMA, in 59% of patients (n=142) according to CT and in 93% of patients (n=224) according to BIA (figure 2a). The prevalence of cachexia was 37% (n=88) with MUAMA as muscle measurement, 43% (n=103) with CT and 48% (n=115) with BIA. Eighty-six patients (36%) were cachectic according to all muscle measurements, 123 patients (51%) were not cachectic according to all muscle measurements and disagreement in presence of cachexia occurred in 13% of patients (n=32, figure 2b). Weight loss >5% was the factor with the highest influence on the diagnosis of cachexia: out of 88 patients in the cachexia MUAMA category, 78 were already diagnosed by the presence of >5% weight loss. This was 78/103 in the cachexia-CT group and 78/115 in the cachexia-BIA group (figure 2c, 2d and 2e).
Figure 2a. Low muscle mass according to three measurements of muscle mass (n=11 had normal muscle mass according to all three measurements)

Figure 2b. Overlap in diagnosis of cachexia with different muscle measurements

Figure 2c. Origin of cachexia diagnosis (with MUAMA for muscle, n=88)

Figure 2d. Origin of cachexia diagnosis (with CT for muscle, n=103)

Figure 2e. Origin of cachexia diagnosis (with BIA for muscle, n=115)

Association between cachexia and features, quality of life and survival

Patients with cachexia showed more clinical symptoms and had poorer survival than patients without cachexia, irrespective of type of muscle measurement applied: Patients with cachexia were more frequently anorectic (57-61% by FAACT-A/CS, dependent on type of muscle measurement) than patients without cachexia (35-39%, p <0.01). This was also seen for fatigue: cachexia 31-32 points on FACIT-
Muscle mass in diagnostic criteria of cachexia

fatigue scale versus no cachexia 37 points, p<0.005. Presence of inflammation and low hand grip strength was significantly higher in patients with cachexia (71-72% and 42-43%) compared to patients without cachexia (53-57% and 26%, p<0.05) for two of the three muscle measurements in the diagnostic criteria of cachexia. Furthermore, performance status, overall quality of life, physical functioning, role functioning, cognitive functioning and social functioning were all significantly different between patients with cachexia compared to patients without cachexia (p<0.01) for the three muscle measurements (table 2).
### Table 2. Differences in features of cachexia and quality of life between cachexia groups defined by different muscle measurements

<table>
<thead>
<tr>
<th></th>
<th>MUAMA for muscle</th>
<th>CT for muscle</th>
<th>BIA for muscle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cachexia (n=88) %</td>
<td>No cachexia (n=153) %</td>
<td>p</td>
</tr>
<tr>
<td>Appetite</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAS† (n=153)</td>
<td>70 (38-86)</td>
<td>80 (54-94)</td>
<td>0.007</td>
</tr>
<tr>
<td>VAS≤70#</td>
<td>51</td>
<td>39</td>
<td>0.076</td>
</tr>
<tr>
<td>FAACT† (n=153)</td>
<td>35 (29-40)</td>
<td>40 (36-42)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>FAACT≤37#</td>
<td>60</td>
<td>39</td>
<td>0.002</td>
</tr>
<tr>
<td>Inflammation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRP† (n=153)</td>
<td>22 (6-50)</td>
<td>9 (4-25)</td>
<td>0.002</td>
</tr>
<tr>
<td>CRP≥8#</td>
<td>71</td>
<td>57</td>
<td>0.048</td>
</tr>
<tr>
<td>Unknown</td>
<td>n=12</td>
<td>n=23</td>
<td></td>
</tr>
<tr>
<td>Hand grip strength</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5th percentile#*</td>
<td>41</td>
<td>29</td>
<td>0.124</td>
</tr>
<tr>
<td>Fatigue (FACT-F)‡</td>
<td>31±13</td>
<td>37±11</td>
<td>0.002</td>
</tr>
<tr>
<td>WHO performance status#</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>22</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>57</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>≥2</td>
<td>21</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>n=25</td>
<td>n=45</td>
<td></td>
</tr>
<tr>
<td>EORTC QLQ C30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality of life‡</td>
<td>52±23</td>
<td>62±23</td>
<td>0.002</td>
</tr>
<tr>
<td>Physical functioning†</td>
<td>70 (47-87)</td>
<td>80 (67-93)</td>
<td>0.001</td>
</tr>
<tr>
<td>Role functioning†</td>
<td>67 (33-67)</td>
<td>67 (50-100)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Emotional functioning†</td>
<td>71 (58-83)</td>
<td>75 (58-92)</td>
<td>0.357</td>
</tr>
<tr>
<td>Cognitive functioning†</td>
<td>83 (67-100)</td>
<td>92 (83-100)</td>
<td>0.140</td>
</tr>
<tr>
<td>Social functioning†</td>
<td>67 (50-100)</td>
<td>83 (67-100)</td>
<td>0.006</td>
</tr>
</tbody>
</table>

†median (IQR), Mann-Whitney test
‡mean±sd, independent t-test
#%, chi²
*reference values (21)
Finally, cachectic patients had a worse overall survival compared to non-cachectic patients after adjustment for age, sex, tumour type, treatment line and comorbidity: HR 2.00 (1.42-2.83), p<0.001 for cachexia with MUAMA for muscle; HR 1.64 (1.15-2.34), p=0.006 for cachexia with CT for muscle and HR 1.50 (1.05-2.14), p=0.025 for cachexia with BIA for muscle (table 3).

Table 3. Multiple Cox regression analyses of the association between cachexia with different muscle measurements and survival (n=202 patients with stage IV cancer)

<table>
<thead>
<tr>
<th></th>
<th>HR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cachexia, MUAMA for muscle</td>
<td>2.00 (1.42-2.83)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cachexia, CT for muscle</td>
<td>1.64 (1.15-2.34)</td>
<td>0.006</td>
</tr>
<tr>
<td>Cachexia, BIA for muscle</td>
<td>1.50 (1.05-2.14)</td>
<td>0.025</td>
</tr>
</tbody>
</table>

Adjusted for age, sex, tumour type, treatment line and comorbidity

Discussion

This is the first study to assess the effect of different measures of muscle mass on the diagnosis of cancer cachexia. Although a large disagreement of 85% on presence of low muscle was found, this had only limited effect on the diagnosis of cancer cachexia. The main reason is that the majority of patients were already defined cachectic by concurrent weight loss of >5% weight loss in the previous six months, which thus appeared to be the factor with the highest influence on the diagnosis of cachexia. Irrespective of type of muscle measurement used, patients with cachexia suffered more often from anorexia, inflammation, low hand grip strength and fatigue, lower quality of life scores and had worse overall survival compared to patients without cachexia.

A previous study also described disagreement between different muscle measures in patients with cancer (25), whereby low muscle mass according to mid-upper arm muscle circumference was prevalent in 15% of patients and according to DEXA in 67% of the same patients. Another study showed that prevalence of low muscle mass ranged between 52 and 86% in elderly patients, dependent of type of muscle measurement and chosen cut-off value (26). The effect of the disagreement in detection of low muscle mass on the diagnosis of cachexia has not been studied previously. We found that prevalence of low muscle mass depended on the type of muscle measurement used, however these differences in low muscle mass had little influence on the diagnosis of cancer cachexia.
Recently, the diagnostic criteria of cancer associated weight loss were revised which led to a grading system based on BMI adjusted weight loss cut-off points. Even a subtle amount of weight loss of more than 2.4% was significantly related to shorter survival (27). Muscle measures were not available in this study but the authors have planned to incorporate these measures into the grading system (27). When the adaption of the grading system will be prepared, a number of issues need to be addressed. For example, our study showed that cut-off values for low muscle mass need to be (re-) validated because current muscle measures with their accompanying cut-off values give different results. Furthermore, attention must be paid to the accuracy and practical availability of measurements. CT, DEXA or MRI are regarded as the most accurate methods to measure muscle mass, however these methods are not frequently used in clinical practice. Measurement of mid-upper arm muscle area has been more frequently used in clinical practice but is less accurate due to a high inter-rater variability (28). Muscle mass measured with BIA needs to be interpreted with caution and cannot be used in patients with altered fluid balance (28). As CT scans are part of routine tumour assessment, this measurement should be made available for clinicians as well.

In our study, cachexia was associated with anorexia, inflammation, fatigue, reduced quality of life and reduced survival. This result is in line with the results in earlier studies (1-4,8,29-32). Effective interventions for cachexia with improvement of appetite, fatigue, quality of life and survival are eagerly awaited. A validated diagnostic framework will help to select the right target group for interventions.

A strength of our study is that we were able to compare three different muscle measurements within each patient. Within-patient measurements were always performed by the same researcher, and CT analyses were performed by 2 trained and qualified researchers only, whereby inter-observer differences were evaluated and found to be almost absent. Due to logistic reasons the CT scans, made for diagnostic purposes, were not always performed on the same day as the measurements of BIA and MUAMA. Median (IQR) of days between CT scan and the other measures was 17 (7-29) days. However, we do not think that this limitation explains the results we found. Furthermore, muscle mass assessment at T4 level still needs validation. Another limitation is the recall of body weight of 6 months ago. Although Haverkort et al (33) showed that self-reported body weight is reliable, recall of body weight might be more difficult.

In conclusion, this is the first study comparing different muscle mass measurements in the diagnostic framework of cachexia. Despite a large disagreement between
muscle measures in identifying a low muscle mass in patients, the effect on the diagnosis of cancer cachexia was limited. Future studies should focus on refinement of the diagnostic framework of cancer cachexia and specifically the role for muscle measurements in the diagnosis of cancer cachexia.
References


Muscle mass in diagnostic criteria of cachexia


