Received: 28 June 2023 | **Accepted:** 29 Aug 2023 **Genel Tıp Derg. Volume** 33/**Issue** 6 (December), 746-752
DOI: 10.54005/geneltip.1320764

ORIGINAL ARTICLE

Evaluation of Nutritional Status in Cancer Patients Underwent Radiotherapy: The Results of Biochemical, Body Composition with Bioelectrical Impedance Analysis, Anthropometric Measurements, and Patient-Generated Subjective Global Assessment

Radyoterapi Alan Kanser Hastalarında Beslenme Durumunun Değerlendirilmesi: Biyokimyasal, Biyoelektrik İmpedans Analizi ile Vücut Bileşimi, Antropometrik Ölçümler ve Hasta Tarafından Yapılan Subjektif Global Değerlendirme Sonuçları

[1]Sumerya Duru Birgi, [2]Dilsat Bas, [3]Seniz Ozturk, [4]Pervin Hurmuz, [5]Erdem Karabulut, [6]Ahmetcan Caglar, [4]Melis Gultekin, [4]Gozde Yazici, [4]Gokhan Ozyigit

[1]Ankara University Faculty of Medicine, Türkiye
[2]Acıbadem Altunizade Hospital Department of Nutrition and Dietetics, İstanbul, Türkiye
[3]Hacettepe University Faculty of Medicine, Department of Nutrition and Dietetics, Ankara, Türkiye
[4]Hacettepe University Faculty of Medicine, Department of Radiation Oncology, Ankara, Türkiye
[5]Hacettepe University Faculty of Medicine, Department of Biostatistics, Ankara, Türkiye
[6]Hatay Education and Training Hospital, Hatay, Türkiye

Correspondence

Sumerya Duru Birgi, Ankara University Faculty of Medicine, Department of Radiation Oncology, Ankara

E-Mail: sumeryaduru03@hotmail.com

How to cite ?

Duru Birgi S, Baş D, Öztürk Ş, Hürmüz P, Karabulut E, Çağlar A, Gültekin M, Yazıcı G, Özyiğit G. Evaluation of Nutritional Status in Cancer Patients Underwent Radiotherapy: The Results of Biochemical, Body Composition with Bioelectrical Impedance Analysis, Anthropometric Measurements, and Patient-Generated Subjective Global Assessment. Genel Tıp Derg. 2023;33(6):746-52.

ABSTRACT

Aim: This study aims to evaluate the nutritional status and the effect of radiotherapy (RT) on nutrition in all ambulatory cancer patients.
Material and Method: In this prospective observational study 105 cancer patients with various diagnoses treated between 2013 and 2014 were evaluated. All patients were ≥18 years old and had Karnofsky Performance Status ≥70. Anthropometric measurements, body composition with bioelectric impedance and patient-generated Subjective Global Assessment (PG-SGA) tools were used. The height, weight, body mass index (BMI), triceps skin fold thickness, mid-upper arm circumference, hemoglobin and serum albumin levels were determined twice before and after RT. Additionally, nutrition-related symptoms and short-term weight loss results were determined by PG-SGA questionnaires.
Results: The patients' median age was 53 years (range, 18-82 years). At initial evaluation 74 patients were well nourished using the PG-SGA global rating. Malnutrition developed in totally 33 of these 74 patients after RT. The PG-SGA results after RT were significantly worse than before treatment. PG-SGA revealed no significant relationship between nutritional status prior to RT and the parameters including gender, age, mean weight, BMI, disease duration, pre-RT hemoglobin and albumin levels. Post-RT evaluation showed a significant relationship between deterioration (PG-SGA B-C) and mean weight, BMI, serum albumin, hemoglobin levels and concomitant chemotherapy. Gastrointestinal and head and neck cancer patients had the most deterioration after RT. The weight, BMI, fat-free mass, total body water and the percentage weight loss of the patients at the end of RT were significantly lower than the initial assessment.
Conclusion: It is considerable to use multiple tools for nutritional monitoring in terms of an effective and comprehensive assessment of malnutrition. Patients who received RT to the head and neck and upper abdomen region had a high risk of deterioration after treatment. These patients should be monitored carefully during all treatment periods.

Keywords: Nutrition assessment, Cancer, Radiotherapy, Bioelectrical impedance, Anthropometry

ÖZ

Amaç: Bu çalışma ayaktan tedavi gören tüm kanser hastalarında beslenme durumunu ve radyoterapinin (RT) beslenme üzerine etkisini değerlendirmeyi amaçlamaktadır.
Gereç ve Yöntem: Bu prospektif gözlemsel çalışmada 2013-2014 yılları arasında çeşitli tanılarla tedavi edilen 105 kanser hastası değerlendirildi. Tüm hastalar ≥18 yaşındaydı ve Karnofsky Performans Durumu ≥70 idi. Antropometrik ölçümler, biyoelektrik impedans ile vücut kompozisyonu ölçümü ve hasta tarafından oluşturulan Subjektif Global Değerlendirme (PG-SGA) araçları kullanıldı. RT öncesi ve sonrası olmak üzere iki kez boy, kilo, vücut kitle indeksi (VKİ), triseps deri kıvrım kalınlığı, orta-üst kol çevresi, hemoglobin ve serum albumin düzeyleri belirlendi. Ayrıca beslenme ile ilgili semptomlar ve kısa süreli kilo kaybı sonuçları PG-SGA anketleri ile değerlendirildi.
Bulgular: Hastaların medyan yaşı 53 yıl (aralık; 18-82 yıl) idi. PG-SGA global değerlendirmesine göre ilk değerlendirmede 74 hasta iyi beslenmiş grupta yer almaktaydı. Bu 74 hastanın 33'ünde RT'den sonra malnütrisyon gelişti. RT sonrası PG-SGA sonuçları, tedavi öncesine göre önemli ölçüde daha kötüydü. PG-SGA, RT öncesi beslenme durumu ile cinsiyet, yaş, ortalama ağırlık, VKİ, hastalık süresi, RT öncesi hemoglobin ve albumin seviyeleri gibi parametreler ile anlamlı bir ilişki göstermedi. RT sonrası değerlendirmede, beslenmede bozulma (PG-SGA B-C) ile ortalama ağırlık, VKİ, serum albumin, hemoglobin düzeyleri ve eş zamanlı kemoterapi arasında anlamlı bir ilişki gösterildi. Gastrointestinal ve baş-boyun tümörleri olan hastalar, RT'den sonra en fazla kötüleşmeye sahipti. Hastaların kilosu, VKİ, yağsız kitlesi, toplam vücut suyu ve RT sonunda kilo kaybı yüzdesi ilk değerlendirmeye göre anlamlı derecede düşüktü.
Sonuç: Beslenme monitörizasyonu için çoklu ölçekler kullanılması malnutrisyonun etkin ve kapsamlı şekilde değerlendirilebilmesi açısından oldukça önemlidir. Baş-boyun ve üst karın bölgesine RT uygulanan hastalarda tedavi sonrası beslenmede kötüleşme riski yüksektir. Bu hastalar tüm tedavi dönemlerinde dikkatle izlenmelidir.

Anahtar Kelimeler: Beslenme Değerlendirmesi, Kanser, Radyoterapi, Biyoelektriksel impedans analizi, Antropometri

Peer-Review: Double anonymized - Two External
Plagiarism Checks: Yes - iThenticate
Complaints: geneltip@selcuk.edu.tr

Selcuk University Press
Genel Tıp Dergisi | e-ISSN: 2602-3741
https://dergipark.org.tr/tr/pub/geneltip
https://yayinevi.selcuk.edu.tr/

Introduction

Nutritional supportive care is an increasingly important issue in the management of cancer patients. The incidence of malnutrition in cancer patients has been reported high with the range of 15–40% at diagnosis and up to 40-80% during treatment (1). In 2015 the European Society for Clinical Nutrition and Metabolism (ESPEN) accepted "a state resulting from lack of uptake or intake of nutrition causing altered body composition (diminished FFM) and body cell mass leading to decreased physical and mental function and worsened clinical outcome from disease" as the definition of malnutrition (2). The type of tumor, stage of disease, and type of anticancer therapy may affect the nutritional status (3,4,5).

Radiotherapy (RT) may result in reduced oral intake leading to malnutrition because of related complications such as mucositis, dysphagia, odynophagia, xerostomia, loss of appetite, and fatigue during or after the treatment (6). Malnutrition may cause treatment interruptions, infections, decreased response to treatment, and impairment in the quality of life (QoL) in addition to influenced hospitalization rates and shortened overall survival (7,8). With nutritional screening and a complete nutritional assessment, it is necessary to identify patients who are undernourished or at a high risk of malnutrition to support and interfere in time (7). Therefore, the European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines mandate regular assessment of the risk of malnutrition in all cancer patients and guide intervention strategies accordingly (5). Various nutritional screening tools with high specificity and sensitivity such as subjective global assessment (SGA), patient-generated subjective global assessment (PG-SGA), nutrition risk index (NRI), malnutrition universal screening tool (MUST) and anthropometric measurements have been recommended to assess the nutritional status in recent studies but none of them alone provides sufficient monitorization (9-11). SGA is cost-effective, can be performed by any health professional, and is easy to use. PG-SGA is adapted from SGA and improved specifically for oncology patients in practice, and has been used with high quality amongst other tools worldwide (12). The oncology dietetic practice groups of the American Dietetic Association and Australian Dietetic Association proposed it as a standard instrument for the nutrition assessment of cancer patients (13). Bauer et al. have shown that PG-SGA has high sensitivity (98%) and specificity (82%) in detecting malnutrition in cancer patients (14). Despite its advantages, PG-SGA still has not gained common use among many centers. Since 2019, a global consensus has recently been reached based on a two-step approach for the diagnosis of malnutrition. With using a validated tool, this Global Leadership Initiative on Malnutrition (GLIM) criteria, it is possible to screen for malnutrition risk as well as to determine its degree and severity (15,16). The use of body composition measurement in conjunction with the GLIM criteria allows for improving performance over using anthropometric measurement alone (17).

In our observational study which had been designed before these criteria, we aimed to evaluate nutritional alteration in cancer patients with a combination of tools including anthropometric, biochemical parameters, body composition with bioelectric impedance (BIA), and PG-SGA twice both before and after RT.

Material and Method

Patients

Between October 2013 and February 2014 one hundred and five cancer patients candidates for RT were enrolled in this prospective observational study. All patients were ≥18 years old and had Karnofsky Performance Score ≥70. Volunteer patients were included irrespective of diagnosis and treatment aim. The present study (protocol number: GO 13/523- 18) was approved by the Ethics Committee of Hacettepe University Faculty of Medicine and all patients signed an informed consent form.

Nutrition Assessment

All participants underwent a baseline nutritional assessment including BIA, anthropometric measurements, biochemical parameters, and PG-SGA. All patients were required to complete the first section of the PG-SGA tool including anthropometric measurements, food intake, symptoms, and functional capacity. The remaining parts which included patient history (including information about age, diagnosis, metabolic demand and steroid usage), physical examination (subcutaneous fat loss, muscle wasting, and edema), and nutritional status were completed by dieticians. At the end of the consultation, the dieticians ranked the nutritional status as well nourished (PG-SGA-A), moderately malnourished (PG-SGA-B), and severely malnourished (PG-SGA-C) as a global rating. For evaluation, malnutrition was defined as either PG-SGA-B or PG-SGA-C. Ranges of 0 to 5 points were given relative to the dependent impact on nutritional status for each component of the PG-SGA. Based on the total score obtained, higher scores were associated with an increased risk of nutritional deterioration and scores ≥9 indicated a critical need for nutritional intervention and/or symptom management. (18). All patients were evaluated twice; both at the beginning and at the end of RT.

Anthropometric – Biochemical Indicators

The anthropometric parameters measured were; weight (W), height (H), mid-upper-arm circumference (MUAC) and triceps skinfold thickness (TSF). Body mass index (BMI) was calculated from current W and H by using the formula: weight/height2 (kg/m2). In our study for patients under 65 years, BMI was classified by WHO classification combining overweight and obese limits and for over 65 years old patients the limits were BMI≤ 22 undernutrition, 22<BMI<29 acceptable weight, BMI≥29 overweight /obese using previous longitudinal studies (19,20). Body W, fat-free mass (FFM), and total body water (TBW) were measured using the TANITA TBF-418 MA total body composition analyzer. Serum Hb and albumin levels were measured twice; at the beginning and at the end of treatment. Albumin and Hb were evaluated using the colorimetric method. The cut-off point for albumin and Hb were 3,5 mg/dl and 11 g/dl, respectively (21). Values lower than these points were assessed as nutritional risk on account of visceral protein depletion and anemia.

Statistics

Statistical analysis was performed by statistics software; SPSS 16 (Chicago, USA). Numeric data were presented as mean, standard deviation, median, maximum and minimum while categorical data were presented as numbers and percentages. Data were analyzed descriptively, and the differences among groups were analyzed using the χ-square and Fisher exact Test. Also, Independent Sample T-Test was used to analyze the presence of a difference in age, W, BMI, disease duration, Hb and Albumin levels and other nutrition-related parameters between the groups before and after RT treatment. Survival analysis was performed using the Kaplan-Meier method. Statistical significance was accepted as p<0.05.

Results

Patient characteristics and RT dose schedules are given in Table-1. Nutrition-related parameters are given in Table-2 and Table-3. The median age was 53 years (range, 18-82 years). Breast cancer was the most common type of cancer among our patients (32%). Most of the participants were in stage II and III (30% and 31%) disease. Twenty-six patients (25%) had comorbid diseases distributed as Diabetes Mellitus (DM) in 10 patients, hypertension (HT) in 11 patients, cardiovascular disease in three patients, renal disease in one patient and ulcerative colitis in one patient. Acute toxicities were evaluated according to 'RTOG/ EORTC Radiation Toxicity Grading. Acute toxicities were observed as; hematological toxicity in one (1%), dermatological toxicity in five (4.8%), gastrointestinal system (GIS) toxicity in 17 (16.2%), genitourinary system (GUS) toxicity in two (1.9%), oesophagitis in 18 (17.1%), oral mucositis in five (4.8%) and others in three (2.9%) patients.

The average weight was 73.8 ± 15.6 kg and the average height was 163.3 ± 9.5 cm while the average BMI was 27.6 ± 5.7 kg/m2. Patients lost an average weight of 1.4 ± 8.2% kg of their previous six-month weight during RT. Malnutrition developed in totally 33 of these 74 patients after RT. On initial assessment, 74 patients (70.4%) were classified as well-nourished, 23 patients (22%) as moderately malnourished and 8 patients (7.6%) as severely malnourished according to PG-SGA global rating (Table-4). The PG-SGA results and total score at the end of RT were statistically worse than before RT (p<0.0001). PG-SGA detected no significant correlation between nutritional status prior to RT and the parameters including gender, age, average weight, BMI, disease duration, pre-RT Hb and albumin levels, and also anticancer therapies the patients received. Post-RT evaluation showed a significant relationship between deteriorated nutrition (PG-SGA B-C) and mean weight, BMI, serum Albumin, and Hb levels,

Table 1. Patient and treatment characteristics

Parameters	Number (n)	Percentage (%)
Gender		
Woman	63	60
Man	42	40
Type of cancer		
Breast	34	32.4
Head and neck	14	13.3
Thoracic	13	12.4
GIS	20	19
GUS	6	5.7
CNS	8	7.6
Others	10	9.5
Stage		
Stage 1	14	13.3
Stage 2	31	29.5
Stage 3	33	31.4
Stage 4	17	16.2
Not evaluated	10	9.5
Treatment before RT		
Chemotherapy	15	14.3
Surgery	29	27.6
Surgery and Chemotherapy	50	47.6
None	11	10.5
RT Area		
Brain	6	5.7
Head and neck	24	22.9
Thorax	11	10.5
Breast	33	31.4
Upper Abdomen	13	12.4
Lower Abdomen	14	13.3
Others	4	3.8
RT type		
3DCRT	36	34.3
IMRT	69	65.7
RT Aim		
Curative	96	91.4
Paliative	9	8.6
Acute Toxicity	51	48.5
Grade I	18	17.1
Grade II	30	28.5
Grade III	3	2.9

Abbrevations: GIS= Gastrointestinal System, GUS= Genitourinary System, CNS= Central Nerve System, RT=Radiotherapy, CT= Chemotherapy, 3 DCRT= Three Dimensional Conformal Radiation Therapy, IMRT= Intensity Modulated Radiation Therapy

concomitant CT with RT, and irradiated regions such as head and neck or upper abdomen. Gastrointestinal system and head and neck cancer patients had the most deterioration while breast cancer had the least after RT (p=0.024) (Table-5). The distribution of nutrition-related parameters on the bases of mainly diagnostic groups is shown in Table-6. Post-RT nutritional status worsened significantly as the disease stage increased (p=0.002). The percentage of weight loss prior to RT and at the end of the RT group were significantly higher in the PG-SGA B-C (p<0.001). Deteriorated food intake, symptoms, functional capacity and activity changes were observed in the PG-SGA assessment, and are shown in Table 7-9. Metabolic demand, steroid use, RT total dose, fraction dose or nutrition supplement during RT had no significant association with nutritional status. At baseline assessment, it was determined that eight patients were severely malnourished but only six patients used nutrition supplements during RT and two of them rejected nutrition supplements. The patient's W, BMI, FFM, TBW, the percentage weight loss at the end of RT were found statistically significantly worse than before RT (p <0.001) (Table-2).

Although our study cohort is small and heterogeneous to investigate overall survival (OS), we evaluated the relationship between SGA, BMI (both before and after

RT), Hb level (before and after RT), Alb level (before and after RT), W, the percentage weight loss at the end of RT and OS and had found no impact following a follow up of median 29 months (range; 1-32 months) as expected.

Table 2. Anthropometric, biochemical, and BIA measurement parameters

Parameter	Before RT (mean±SD)	After RT (mean±SD)	P value
Weight (kg)	73.7 ± 15.6	71.2 ± 15.2	<0.001
BMI	27.6 ± 5.7	26.7 ± 5.7	<0.001
HB level (mg/dl)	12.2 ± 1.3	11.9 ± 1.6	0.370
Albumin level (mg/dl)	4.2 ± 0.41	4.0 ± 0.48	0.173
TST (mm)	21.6 ± 7.8	21.2 ± 8.1	0.022
MUAC (cm)	29.9 ± 4.6	29.5 ± 4.8	0.015
Total body fat (%) (TBF)	30.1 ± 10.1	29.9± 10.7	0.613
Fat-free mass (kg) (FFM)	50.7 ± 9.6	49.1 ± 8.6	<0.001
Total body water (kg) (TBW)	37.1± 7.0	36.0± 6.3	<0.001
Percentage of weight loss before RT	% - 0.5 ± 5.1	% + 3.2 ± 4.5	<0.001
Total Score	6.05 ± 5.2	10.4 ± 7.2	<0.001

Abbrevations: BMI= Body Mass Index, HB= Hemoglobin, Alb= Albumin, TST= Triceps skinfold thickness, MUAC= Mid-upper arm circumference BIA= Bioelectric Impedance

Table 3. Evaluation of changes in BMI group by time. There is a significant decrement in BMI in all groups p=0.005

			BMI After RT			
			Underweight	Acceptable weight	Overweight/obese	Total
BMI Before RT	Underweight	Number	7	1	0	8
		Percentage	87.5%	12.5%	0%	100%
	Acceptable weight	Number	5	28	0	33
		Percentage	15.2%	84.8%	0%	100%
	Overweight/obese	Number	0	8	56	64
		Percentage	0%	12.5%	87.5%	100%
	Total	Number	12	37	56	105
		Percentage	11.4%	35.2%	53.3%	100%

Table 4. Evaluation of the changes in PG-SGA groups by time. There is a significant deterioration in the PG-SGA of the patients p<0.001

			Global Evaluation After RT			
			PG SGA-A	PG SGA-B	PG SGA-C	Total
Global Evaluation Before RT	PG SGA-A	Number	37	28	9	74
		Percentage	50%	37.8%	12.2%	100%
	PG SGA-B	Number	4	7	12	23
		Percentage	17.4%	30.4%	52.2%	100%
	PG SGA-C	Number	0	1	7	8
		Percentage	0%	12.5%	87.5%	100%
Total		Number	41	36	28	105
		Percentage	39%	34.3%	26.7%	100%

Table 5. Distribution of PG-SGA according to diagnostic groups of cancer. GIS, GUS, Head and neck, and also lung-diagnosed tumors seem to be at nutritional risk (p=0.001)

DIAGNOSTIC GROUPS OF CANCER			Global Evaluation		
			PG-SGA-A	PG-SGA-B and PG SGA-C	Total
	Lung	n	8	5	13
		%	61.5%	38.5%	100%
	Breast	n	32	2	34
		%	94.1%	5.9%	100%
	Head and Neck	n	9	5	14
		%	64.3%	35.7%	100%
	GIS	n	10	10	20
		%	50%	50%	100%
	CNS	n	7	1	8
		%	87.5%	12.5%	100%
	GUS and Gyneacologyc	n	3	3	6
		%	50%	50%	100%
	Others	n	5	5	10
		%	50%	50%	100%
Total		n	74	31	105
		%	70.5%	29.5%	100%

Abbreviations: GIS: Gastrointestinal System, CNS: Central Nerve System, GUS: Genitourinary System

Table 6. Distribution of nutrition-related parameters on the bases of mainly diagnostic groups.

Diagnosis	HEAD AND NECK			GIS			LUNG		
Parameter	Before RT (mean±SD)	After RT (mean±SD)	P value	Before RT (mean±SD)	After RT (mean±SD)	P value	Before RT (mean±SD)	After RT (mean±SD)	P value
Weight (kg)	71.8±22.5	66.3±20.5	0.001	68.0±14.4	62.8±13.3	0.011	77.8±13.2	76.6±12.7	NS
BMI	26.6±7.4	24.6±6.4	0.002	24.9±4.1	23.1±4.2	0.006	26.1±3.8	25.7±3.5	NS
TBF (%)	23.9±11.0	22.5±12.4	NS	21.9±8.2	19.3±9.4	0.037	21.0±3.3	22.6±4.0	0.038
FFM (kg)	52.3±5.5	49.8±5.7	0.023	51.8±10.1	49.4±9.5	0.001	59.9±9.7	58.1±8.5	NS
TBW (kg)	38.3±4.1	36.5±4.2	0.023	37.9±74	36.2±6.9	0.001	43.8±7.1	42.6±6.2	NS
TST (mm)	17.3±7.9	16.5±8.0	NS	15.4±7.1	14.8±6.6	0.034	18.6±7.4	18.3±7.1	NS
MUAC (cm)	28.9±5.1	27.9±5.2	0.003	27.3±3.1	26.6±3.6	0.027	29.4±2.9	28.9±1.6	NS
Percentage of weight loss before RT	4.2±2.6	8.2±7.1	NS	2.6±2.0	6.4±3.4	0.046	3.4±2.7	5.6±3.5	NS

Abbrevations: BMI= Body Mass Index, TBF= Total body fat, FFM=Fat Free Mass, TBW=Total Body Water, TST= Triceps skinfold thickness, MUAC= Mid-upper arm circumference, NS: Not significant

Table 7. Evaluation of Current Food intake during RT

Food Intake	Before RT	After RT	P value (<0.001)
Normal food but less than normal amount	22 (21%)	32 (30.5%)	
Little solid food	5 (4.8%)	15 (14.3%)	
Only liquids	1(1%)	3(2.9%)	
Only nutritional supplements	0	0	
Very little of anything	0	2 (1.9%)	
Only tube feedings or only nutrition by vein	0	0	
normal	77 (73.2%)	53 (50.5%)	

Table 8. Evaluation of symptoms and functional capacity

SYMPTOMS	Before RT		After RT		P value
	N (number)	%(percentage)	N (number)	%(percentage)	
No problems eating					<0.001
yes	42	40.0	72	68.6	
No appetite					<0.001
yes	20	19.0	44	41.9	
Nausea					<0.001
yes	10	9.5	32	30.5	
Constipation					1.000
yes	8	7.6	9	8.6	
Vomiting					0.549
yes	4	3.8	7	6.7	
Diarrhea					0.754
yes	5	4.8	7	6.7	
Dry mouth					0.002
yes	4	3.8	17	16.2	
Feel full quickly					0.344
yes	5	4.8	9	8.6	
Mouth sores					0.004
yes	2	1.9	11	10.5	
Things taste funny					<0.001
yes	10	9.5	32	30.5	
Smells bother me					0.012
yes	6	5.7	18	17.1	
Pain					0.039
yes	1	1.0	8	7.6	
Swallowing problems					<0.001
yes	5	4.8	33	31.4	
Depression, money, and other problems					0.549
yes	7	6.7	4	3.8	
Total	105	100.0	105	100.0	

Table 9. Evaluation of activity and functional capacity in previous 1 month before and after RT (p<0.001)

	Before RT		After RT		P value
	N(number)	%(percentage)	N(number)	%(percentage)	
Activity and Function					<0.001
Normal with no limitations	49	46.7	25	23.8	
Not my normal self but able to be up and about with fairly normal activities	38	36.2	41	39.0	
Not feeling up to most things but in bed or chair less than half the day	14	13.3	29	27.6	
Able to do little activity and spend most of the day in bed or a chair	4	3.8	6	5.7	
Pretty much bed-ridden, rarely out of bed	0	0.0	4	3.8	

Discussion

The incidence of malnutrition in cancer patients has been reported to be higher than 30% and malnutrition is associated with response to treatment as well as tolerance to treatment-related toxicities (1,7). In this study, we evaluated the nutritional status of 105 patients with a combination of assesment tools before and after RT. Radiotherapy caused impaired nutritional status after treatment. Patients with GI and head and neck tumors had the most malnutrition rates after RT.

In a review by Stratton et al., disease location had a significant effect on malnutrition rate when weight loss had been taken as a sole parameter. Malnutrition rates according to primary disease were distributed as 9% in urological cancers and 15% in colorectal cancers, 67% in head and neck cancers, 57-80% in GI tumors, and 85% in pancreatic cancers, respectively (22). Gupta et al. showed that patients with gynecological cancers who had low SGA scores (well nourished) had better survival (23). In our study, where various parameters were used, GI and head and neck tumors showed the most deterioration after RT.

Various methods were used in the literature to assess the nutritional status of the patients. As biochemical indicators, serum albumin level was widely used and has become a favourable parameter (24). Khalid et al. found that serum albumin decreased in patients who received RT (25). Bei Wen Wu et al. detected that patients with GI tumors had lower albumin levels as malnutrition increased (26). In our study, we could not find a significant difference in the serum albumin and Hb levels both before and after RT. Since albumin synthesis is affected by many factors such as liver and renal dysfunctions, inflammation, and fluid overload, it has low sensitivity to evaluate malnutrition (27). Due to controversies in the use of albumin for proper evaluation, some studies recommended the use of anthropometric measurements. Barthelemy et al. used PG-SGA and anthropometric tests in patients with lung cancer who received RT and found that patients with malnutrition had lower MUAC (28). Bei Wen Wu et al. showed that GI cancer patients with malnutrition had lower BMI and TSF along with lower albumin levels (26). In our study, we found a significant decline in the levels of TSF (p=0.022), MUAC (p=0.015), FFM (p<0.001), and TBW (p<0.001) after RT, as in the previous literature. When BMI was utilized, 15-50% of patients had malnutrition (29,30). In our study, the rate increases from 7% to 11% after RT. Obese or overweight patients have low lean body mass however this is usually masked by high body fat, thus, BMI is solely inadequate to evaluate nutritional status. In our study, W and BMI of both patients significantly worsened after RT (p<0.001).

PG-SGA is a specific tool developed for cancer patients to assess nutritional status based on SGA, with 98% sensitivity and 82% specificity (14). PG-SGA evaluates seven parameters including W, nutritional intake, symptom, activity and function, disease-related nutritional needs, metabolic needs and physical examination. Lost in body weight compromises less than 10% of the PG-SGA score and the percentage weight loss prior to RT is correlated with the PG-SGA score (31). Malnutrition has also been reported to have a negative impact on survival in cancer patients (32). Ottery et al. showed that poor PG-SGA score was associated with BMI, the percentage of weight loss, duration of hospital stay as well as survival (18, 33). Martin et al. found a relationship between the diagnosis group, performance score, food intake, short-term percentage weight loss, dysphagia and survival in patients with advanced-stage disease (34). However, due to small and heterogenous patient cohort, we could not find any predictive factor for survival in our study.

There is an effort to find out predictors for malnutrition. JE Montoya et al. assessed cancer patients with SGA and found that the stage of the disease and KPS were predictors for malnutrition (35). Chaves et al. reported that patients at advanced stage and in high-risk groups (head and neck, colorectal, lung, GI cancers) had worse nutritional status, and no relation was detected between age and the duration of the disease (36). In our study W, BMI, concomitant chemotherapy, RT field, levels of Albumin and Hb and the percentage weight loss prior to RT were accepted as predictor factors for malnutrition. Pre-RT treatment schedules did not affect the nutritional status of the patients, but the nutritional status of patients who received concurrent chemotherapy with RT was worse, consistent with the literature (37,38). Although older age was reported as a poor factor, we did not obtain similar results in our study (39,40). Moreover, it was also stated that patients in the advanced stage might show a higher prevalence of malnutrition than those in the early stage, which was consistent with our study (28). RT-related side effects may lead to deterioration of nutritional status of patients (41). The nutritional intervention was found beneficial in terms of weight and quality of life in patients receiving RT for head and neck and GI tumors (42,43).

Conclusion

Proper evaluation of nutritional status of patients before RT is prominent. Rather than only one method, the combination of tools like biochemical, anthropometric measurements and PG-SGA would be preferred. Radiotherapy impaired nutritional status. The most decrease in nutritional function had been observed in GI and head and neck cancers. Our future aim is to investigate the effect of nutritional status on survival within a large and more homogenous cohort of patients.

Acknowledgements: None

Funding: None

Contributors: All authors were involved in the study design, had full access to the survey data and analyses, and interpreted the data, critically reviewed the manuscript and had full control, including final responsibility for the decision to submit the paper for publication.

Conflict of interest: Authors declared no conflict of interest.

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