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Does nutrition influence quality of life in cancer patients undergoing radiotherapy?

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Abstract

Purpose: To investigate in cancer patients referred for radiotherapy (RT): (1) quality of life (QoL), nutritional status and nutrient intake, at the onset and at the end of RT; (2) whether individualised nutritional counselling, despite symptoms, was able to enhance nutrient intake over time and whether the latter influenced the patient's QoL; and (3) which symptoms may anticipate poorer QoL and/or reduced nutritional intake.

Material and methods: One hundred and twenty-five patients with tumours of the head–neck/gastrointestinal tract (high-risk: HR), prostate, breast, lung, brain, gallbladder, uterus (low-risk: LR) were evaluated before and at the end of RT. Nutritional status was evaluated by Ottery's Subjective Global Assessment, nutritional intake by a 24-h recall food questionnaire and QoL by two instruments: EUROQOL and the European Organisation for the Research and Treatment of Cancer (EORTC) Quality of Life Questionnaire (QLQ)-C30.

Results: Baseline malnutrition was prevalent in HR *vs*. LR ($P = 0.02$); nutritional intake was associated with nutritional status ($P = 0.007$); the latter did not change significantly during RT. In LR, baseline energy intake was higher than EER ($P = 0.001$), and higher than HR' intake ($P = 0.002$); the latter increased ($P < 0.03$), in spite of symptom increase anew and/or in severity ($P = 0.0001$). According to both instruments, QoL was always better in LR vs. HR ($P = 0.01$); at the end of RT, QoL improvement in HR was correlated with increased nutritional intake ($P = 0.001$), both remained stable in LR.

Conclusions: Individualised nutritional counselling accounting for nutritional status and clinical condition, was able to improve nutritional intake and patients' QoL, despite self-reported symptoms.

Keywords: Quality of life; Nutrition; Nutritional counselling; Cancer; Radiotherapy

1. Introduction

In cancer patients, malnutrition is multifactorial and bears a negative prognosis [5,29]. Patients submitted to radiotherapy (RT), particularly of the head and neck (HN) or the gastrointestinal (GI) tract, are at higher risk of malnutrition [29]; therapy induced toxicity, e.g. mucositis, xerostomia, taste changes, odynophagia, dysphagia, nausea, vomiting, diarrhoea and anorexia may further compromise nutrition and functional ability [4,7].

Quality of life (QoL) is a subjective multidimensional construct representing functional status, psychosocial well-being, health perceptions and disease/treatment-related symptoms [10]. Each nutrition related factor, nutritional status, nutritional intake and the above mentioned symptoms are thus likely to assume a significant role in the patients' QoL [26]. Although nutrition management has been proposed as auspicious to cancer patients [12], to date there is no evidence-based data to support that concept.

Within this framework, we investigated whether individualised nutritional counselling would improve patient's outcomes, nutritional status and QoL in cancer patients undergoing RT. Our specific aims were to investigate: (1) the patients' QoL, nutritional status and nutrient intake, at the onset and at the end of RT; (2) whether individualised nutritional counselling, despite symptoms, was able to enhance over time nutrient intake and whether the latter influenced the patient's QoL; and (3) symptoms which may anticipate poorer QoL and/or reduced nutritional intake.

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2. Material and methods

2.1. Study design and patient sample

This study was designed as a prospective descriptive study to investigate outcomes of nutritional counselling initiated prior to RT and was approved by the University Hospital Ethics Committee. Between July 2000 and February 2001 all consecutive cancer patients referred to the outpatient Radiotherapy Department were considered eligible. Before the decision of RT planning, the medical staff registered the patients' clinical variables, cancer location and TNM staging [8]. Exclusion criteria comprised: terminally ill patients, renal failure (creatinine $>$ 532 μmol/l), congestive heart failure and hepatic failure (bilirubin $>$ 21 μmol/l). The cohort studied included 125 adult patients, age 63 ± 11 (33–86) years, 83 M:42 F, proposed for RT: primary, adjunctive to surgery or with palliative intent. Patients with tumours of the HN and GI tract were, on the basis of the expected RT-induced GI symptoms, classified as high-risk patients whilst the remaining were considered as low risk. For every patient, radiation-induced symptoms and side effects and their severity were graded according to the recommended RTOG-EORTC Radiation morbidity scoring scheme [25].

Data were recorded in individual sheets preconceived for statistical analysis.

2.2. Study measures

Assessment of nutritional status as described, food intake and dietary advice were performed by a research dietician (PR), at the onset, after 2 weeks and at the end of RT. QoL was evaluated at the onset and at the end of RT.

2.3. Nutritional assessment

Nutritional status was assessed by Ottery's Subjective Global Assessment (SGA), a patient-generated assessment tool validated for cancer patients [19]. The first four sections address weight changes, symptoms (anorexia, nausea, constipation, mucositis, vomiting, diarrhoea, xerostomia, pain), alterations in food intake and functional capacity. Components of metabolic stress: sepsis, neutropenic or tumour fever, and corticoesteroids, and physical examination: subcutaneous fat (triceps skinfold and at the level of the lower ribs in the midmaxillary line), muscle bulk and tone in the temporal, deltoids and quadriceps areas, ankle/sacral oedema, or ascites are added. As a result, nutritional status is categorised in three degrees: normal, moderate and severe malnutrition.

2.4. Nutritional requirements, dietary assessment and counselling

Basal energy requirements were estimated by the World Health Organisation formula [32]. For men: 18–30 years [64.4 × weight (kg) − 113 × height (m) + 3000], 30–60 years [19.2 × weight (kg) + 66.9 × height (m) + 3769]; for women: 18–30 years [55.6 × weight (kg)–1397.4 × height (m) + 146], 30–60 years [36.4 × weight (kg) + 104.6 × height (m) + 3619]. For patients $>$60 years, the Owen et al. formulas [20,21] were used. For men [(879 + 10.2 × weight (kg)) × 4.184] and for women [795 + 7.18 × weight (kg) × 4.184]. These formulas were used due to their higher ability of predicting the actual resting metabolic rate by comparison with the Harris and Benedict formula [11]. Height was copied from the patient's identity card and weight was determined with a Jofre® floor scale. Patient daily estimated energy requirements (EER) were calculated by multiplying basal requirements by a 1.2 activity factor [13]; protein requirements were estimated by comparison with reference values standardised for age and sex [23].

Nutritional intake evaluation was derived from a 24-h-recall food questionnaire, the nutrient content was analysed by the DIETPLAN5 for Windows software (Forestfield software Ltd 2001, Horsham, UK). Individualised dietary advice was based on current foodstuffs, hence neither nutritional supplements nor enteral tube feeding were ever used. Nutritional counselling took into account each patient's current food habits, actual nutritional status, calculated increase in energy and protein requirements to overcome deficits, known food aversions and reported symptoms. The latter were valued in the context of diet adequacy, which may determine variations in the patients' daily meal plan, diet nutrient content, type and amounts of foodstuffs and food texture.

2.5. QoL instruments

QoL was evaluated in every patient by two methods in order to evaluate their relative performance given the significant differences in length of time ascribed to their completion.

The EUROQOL instrument is non-disease-specific and describes and scores health states [2]. On its first part, health is defined in terms of five dimensions: mobility, self-care, usual activities (work, study, housework, family, leisure), pain or discomfort and anxiety or depression. Each dimension is subdivided into three categories, which indicate whether the respondent has no problem, a moderate problem, or an extreme problem. Combinations of these categories define a total of 243 health states. On the second part, the respondent indicates his/her perception of his/her overall health on a visual analogue scale (0 denoting the worst imaginable health state and 100 the best imaginable health state).

The European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC-QLQ C30, version 3.0) is a 30-item cancer specific questionnaire including five functional scales (physical, emotional, cognitive, social, and role), three symptom scales (fatigue,

pain, nausea/vomiting), a global health/QoL scale and six single items assessing symptoms and financial impact of disease [1]. The raw scores were linearly transformed to give standard scores in the range of 0–100 for each of the scales and single items. Higher scores on the functional and global health scales indicated better functioning, whereas higher scores on the symptom scales represent more symptomatology.

2.6. Statistical analysis

This study was based on the intention to treat principle. Target sample consisted of all consecutive cancer patients referred to the outpatient Radiotherapy Department included between July 2000 and February 2001. Sample size was calculated according to Wittes (2002, #721) [33]. Based on the therapeutic intervention period, clinically significant differences were assigned whenever nutritional intake adequacy was accomplished by meeting or overcoming the patients requirements, and an increase of 15–20% in QoL scores was acknowledged [1]. Descriptive patient data concerning nutritional status and intake, symptoms and QoL are expressed as number and percentage, mean or median values and are presented for each diagnosis. In order to increase statistical power, patients were grouped as high (HR) or low-risk (LR). Continuous variables were logarithmically transformed before any parametrical tests were performed. Kruskal–Wallis analysis, the Mann–Whitney *U*-test and Student's *t*-test were used to analyse associations and/or differences in QoL measures, nutritional intake or nutritional status between patient groups. Frequencies were compared by chi-square test. Spearman and Kendal Tau methods were used to determine correlations between nutritional intake or status and QoL dimensions. Multivariate logistic regression analysis was done to identify variables that influence nutritional intake and QoL. For all statistics, significance was accepted at the 5% probability level. SPSS 10.0 (Chicago, USA), EPI–Info 2000 (CDC, Atlanta, USA) and STATISTICA (Statsoft, Tulsa, USA) software were used for analyses.

3. Results

3.1. Patients

Patient's diagnoses, tumour staging and RT treatment protocol are shown in Table 1.

3.2. Nutritional status

Patients' nutritional status categories at the onset and at the end of RT, according to the assigned risk level, are shown in Fig. 1. Before RT, among the HR group, only one patient with oesophageal cancer was well nourished, all patients with stomach cancer, 52% of HN cancer patients and six (13%) patients with CR cancer were malnourished; six (13%) patients with CR cancer were obese (body mass index >30 kg/m^2); severe malnutrition was never observed in LR patients. Either at the onset or at the end of RT, malnutrition (moderate + severe) was more often present in the HR group ($P = 0.02$). Nutritional status remained stable in all but one HN cancer patient whose moderate malnutrition deteriorated.

Table 1
Patient groups and treatment protocol

Location	*n*	Staging (*n*)	Dose (Gray)/fractionation (*n*)/day
GI tract[a]			
Oesophagus (OES)	6	II (1); III (5)	45/25/33
Stomach (STO)	5	I (1); II (2); III (2)	45/25/33
Colorectal (CR)	46	I (13); III (28); IV (5)	50/25/33
Head and neck[a]			
Base of the tongue	3	IV (3)	70–74/30–35/40–47
Salivary gland	1	III (1)	70–74/30–35/40–47
Tonsil	2	II (2)	70—74/30–35/40–47
Nasopharynx	3	III (3)	70–74/30–35/40–47
Oropharynx	3	II (1); IV (2)	70–74/30–35/40–47
Larynx	11	I (1); III (3); IV (7)	70–74/30–35/40–47
Prostate	21	II (15); IV (3)	50/25/33
Breast	7	II (4); III (2); IV (1)	50/25/33
Lung	5	II (2); III (2); IV (1)	50/25/33
Brain	4	I (1); II (2); III (1)	50/25/33
Gallbladder	6	II (1); IV (2)	50/25/33
Uterus	2	II (1); III (1)	50/25/33

n = number of patients or radiation fractions.
[a] Defines high-risk (HR) patients due to the expected RT-induced symptoms; remaining diagnoses are classified as low-risk (LR); no patient had distant metastasis.

At the onset and at the end of RT, only one of the LR patients reported diarrhoea and another anorexia. Throughout RT treatment, only in HR patients did symptoms increase, anew and/or in severity ($P = 0.0001$). Fig. 2 shows the number of patients presenting symptoms at the onset and at the end of RT in HR groups. No patients reported grade 3 or 4 symptomatology.

3.3. Nutritional intake

Patients' median energy intake and median estimated requirements (EER) are shown in Fig. 3.

At the onset, the median energy intake of LR patients was higher than their EER ($P = 0.001$), and higher than the median intake of HR groups ($P = 0.002$). In the latter, baseline median energy intake was lower then their EER, reaching significance only in CR and HN cancer ($P = 0.01$). In all diagnoses baseline nutritional status was associated with nutritional intake ($P = 0.007$) (Kruskal–Wallis analysis adjusted by tumour staging). Despite the more severe symptoms in HR patients, energy intake did increase significantly ($P < 0.03$), narrowing the gap with their

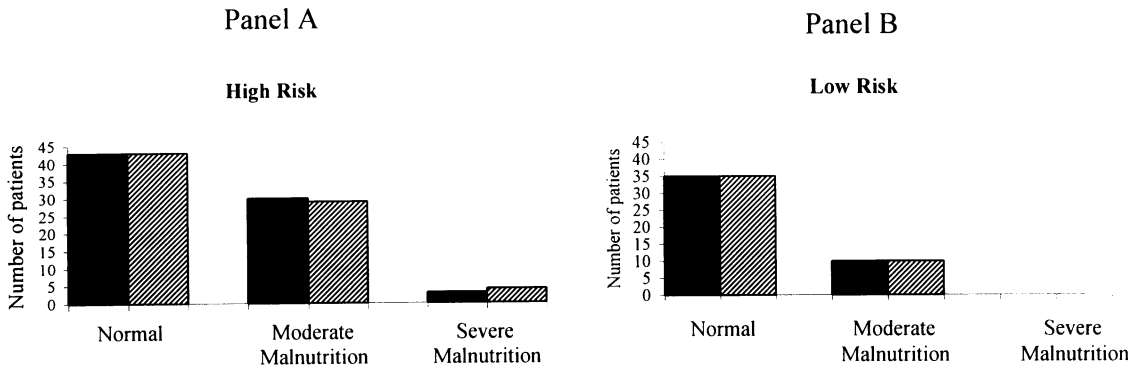

Fig. 1. Nutritional status at the onset ■ and at the end of RT ■.

EER; an improvement spontaneously attributed by patients to the individualised nutritional counselling. Patients with oesophageal and stomach cancer registered similar median increases of 275 kcal (200–425) and 280 kcal (185–400), respectively, a lower increment than in colorectal and HN patients: 410 kcal (352–545) and 510 kcal (358–785), respectively ($P = 0.03$). In the LR group there was a median increase of 70 kcal (NS). Baseline protein intake was similar to requirements in LR patients and higher than in HR patients ($P = 0.003$); in the latter, intake was lower than requirements (NS). Subsequent to counselling, protein intake did increase only in HR patients ($P = 0.08$).

3.4. QoL

The number (percentage) of patients that reported moderate or extreme problems regarding each EUROQOL dimension, at both evaluation set points, are summarised in Table 2.

At any stage and for all cancer patients, impaired usual activities, pain/discomfort and anxiety/depression were the most common problems. Overall and for all QoL dimensions, HR patients presented worse scores than LR patients, either at baseline ($P = 0.001$), or at the end of RT ($P = 0.01$). Patients with oesophageal, stomach and head and neck cancer reported the worse QoL, in both evaluations. With the exception of pain/discomfort, all QoL dimension' scores did improve in spite of RT, though only significantly in HR patients ($P = 0.004$); pain/discomfort became worse throughout RT in association with more severe symptoms: anorexia ($P = 0.001$), diarrhoea ($P = 0.002$), dysphagia ($P = 0.01$) and odynophagia ($P = 0.04$). Nevertheless, nutritional intake was improved.

In HR patients, worse mobility was associated with the presence of malnutrition ($P = 0.01$) or reduced energy intake ($P = 0.0$); usual activities were associated in a similar manner ($P = 0.02/P = 0.03$) as well as anxiety/depression ($P = 0.02/P = 0.01$). Additionally, multivariate analyses identified an association between worse nutritional status and worse mobility ($P = 0.03$) or anxiety/depression ($P = 0.05$), and flagged the association between anxiety/depression and nutritional intake ($P = 0.02$). Nutritional intake improvement was identified as a major determinant of the QoL improvement registered at the end of RT

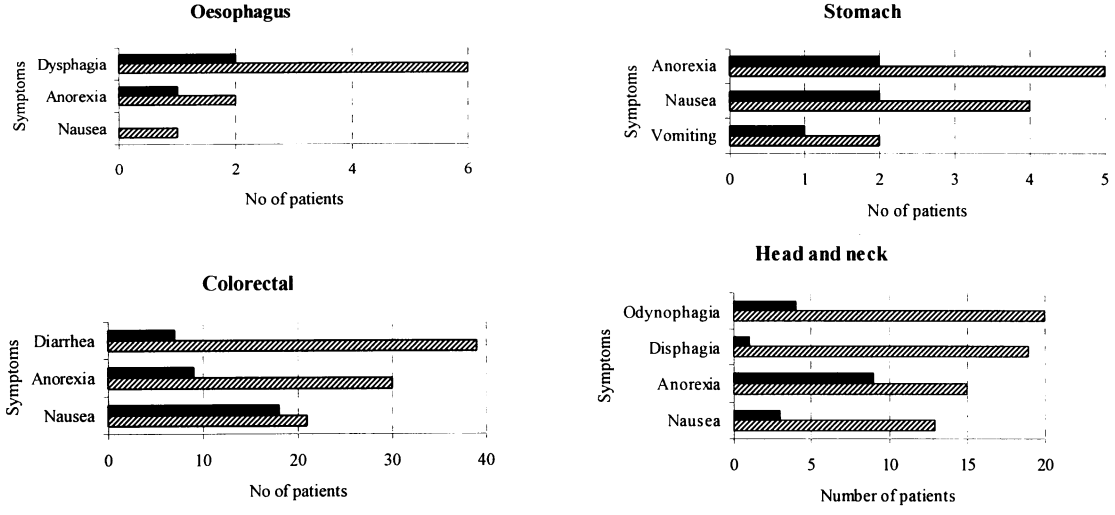

Fig. 2. Number of patients presenting symptoms at the onset ■ and at the end ■ of RT for HR diagnoses. Odynophagia comprised xerostomia, mucositis and taste changes.

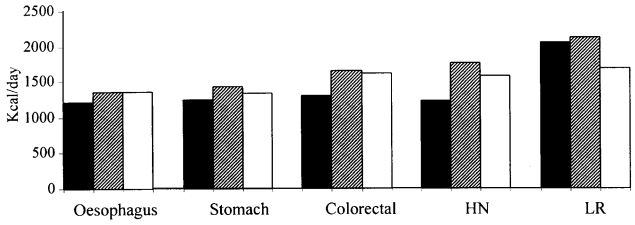

Fig. 3. Median energy intake at the onset ■ and at the end ■ of RT □; median EER.

($r = 0.78$, $P = 0.001$). In LR patients, QoL dimensions were not significantly associated with any nutritional parameter.

Fig. 4 shows the mean self-rated health status (SRHS) on the visual analogue scale.

At the onset, LR patients had a significantly higher mean SRHS when compared to HR patients ($P < 0.03$). At the end, SRHS did increase in all patient groups, though significance was reached only in HR ($P = 0.01$ vs. LR, $P = 0.06$); oesophageal, stomach and HN patients reported the highest increase. In HR patients, baseline malnutrition was associated with lower SRHS ($P = 0.002$) and at the end of RT, whilst improved nutritional status was associated with higher SRHS ($P = 0.03$). Unlike LR patients, energy intake in HR was correlated with SRHS, both at the onset ($r = 0.47$, $P = 0.001$) and at the end of RT ($r = 0.32$, $P = 0.005$). At the end of RT, a multivariate analysis considering nutritional parameters and symptoms as the independent variables and SRHS as the dependent variable, highlighted its only association with nutritional intake ($P = 0.001$). The increase registered in each patients' nutritional intake was correlated with the increase of SRHS ($r = 0.72$, $P = 0.001$) indicating that the patients who improved their energy intake also enhanced their SRHS (Pearson' method).

The average rate of self-reported QoL problems evaluated by the EORTC QLQ C30 instrument, at the onset and at the end of RT, is summarised in Table 3.

At both evaluation set points, the overall QoL pattern was worse in HR patients ($P = 0.002$); the worse dimensions were reported in patients with oesophageal, stomach and head/neck cancer. At the end of RT, in HR patients, function scales were improved ($P = 0.001$) whilst a deterioration was reported for fatigue (NS), pain

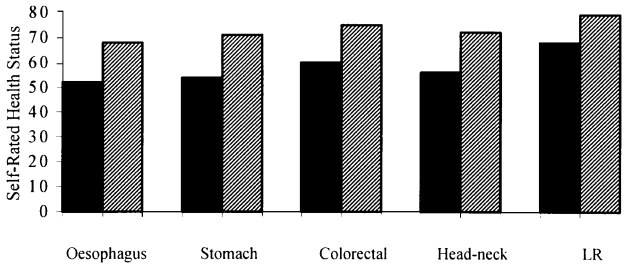

Fig. 4. Patients' mean self-rated health status at the onset ■ and at the end ■ of RT.

Table 2
Patients reporting problems in each EUROQOL dimension at the onset and at the end of RT

EuroQoL	Problem																			
Dimension	Moderate									Extreme										
	OES		STO		CR		HN		LR	OES		STO		CR		HN		LR	
	Onset	End	Onset	End	Onset	End	Onset	End	Onset	End	Onset	End	Onset	End	Onset	End	Onset	End	Onset	End
Mobility	1 (17)	0	0	0	10 (22)	4 (9)	7 (30)	2 (9)	2 (4)	2 (4)	0	0	0	0	7 (15)	0	4 (17)	1 (4)	1(2)	1 (2)
Self-care	1 (17)	1 (17)	0	1 (20)	3 (7)	3 (7)	7 (30)	7 (30)	0	0	1 (17)	0	0	0	2(4)	2 (4)	5 (22)	5 (22)	0	0
Usual activities	3 (50)	1 (17)	3 (60)	1 (20)	19 (41)	5 (11)	10 (43)	4 (17)	1 (2)	1 (2)	3 (50)	0	0	0	15 (33)	1 (2)	15 (52)	3 (13)	1(2)	1 (2)
Pain/discomfort	2 (33)	4 (67)	1 (20)	4 (80)	7 (15)	23 (50)	3 (13)	10 (43)	3 (7)	3 (7)	0	1 (17)	0	1 (20)	1 (2)	20 (43)	1 (4)	12 (52)	2 (4)	2 (4)
Anxiety/ depression	2 (33)	1 (17)	1 (20)	1 (20)	20 (43)	5 (11)	11 (48)	4 (17)	4 (9)	2 (4)	1(17)	0	2 (40)	1 (20)	19 (41)	2 (4)	15 (52)	3 (13)	3 (7)	2 (4)

Data expressed as number (percentage) of patients.

Table 3
Self-reported QoL problems at the onset and at the end of RT

Items	OES ($n = 6$)		STO ($n = 5$)		CR ($n = 46$)		HN ($n = 23$)		LR ($n = 45$)	
	Onset	End	Onset	End	Onset	End	Onset	End	Onset	End
Function scales										
Global QoL	52	69	56	70	68	75	50	73	73	80
Physical function	42	65	40	55	69	74	50	80	74	70
Role function	53	68	42	62	62	78	55	75	80	80
Emotional function	58	63	36	45	65	65	74	74	82	82
Social function	68	74	35	58	69	69	66	86	83	83
Cognitive function	54	65	41	55	38	58	53	72	80	80
Symptoms, scales										
Fatigue	59	64	29	19	26	26	67	52	30	30
Pain	22	58	29	52	25	49	13	60	17	17
Nausea and vomiting	25	45	24	72	48	58	43	18	4	4
Symptoms, single items										
Dyspnea	56	58	2	2	5	5	38	38	2	2
Sleep disturbance	45	45	35	35	39	39	53	53	21	21
Appetite	41	79	19	55	68	68	73	19	6	6
Constipation	2	2	1	1	15	4	8	8	12	12
Diarrhoea	2	2	0	0	59	78	9	9	6	6
Finance	4	4	1	1	8	8	38	38	5	5

($P = 0.003$), nausea/vomiting ($P = 0.04$) and appetite ($P = 0.001$). In the LR group, global QoL was the only improved item ($P = 0.05$).

In HR patients, baseline malnutrition was associated with worse function scales: global QoL ($P = 0.05$), physical ($P = 0.01$), role ($P = 0.02$), cognitive ($P = 0.02$), emotional ($P = 0.01$) and social ($P = 0.01$) as well as with symptoms: poor appetite ($P = 0.001$) or increased fatigue ($P = 0.03$) (Kruskal–Wallis). All associations with function scales were also present at the end of treatment: global QoL ($P = 0.01$), physical ($P = 0.02$), role ($P = 0.02$), cognitive ($P = 0.03$), emotional ($P = 0.01$) and social ($P = 0.04$).

Baseline energy intake was correlated with function scales: global QoL ($r = 0.53$, $P = 0.001$), physical ($r = 0.26$, $P = 0.02$) and emotional ($r = 0.29$, $P = 0.01$) as well as with symptoms: anorexia ($r = 0.52$, $P = 0.001$) and fatigue ($r = 0.60$, $P = 0.001$). At the end of RT, energy intake was correlated with global QoL ($r = 0.50$, $P = 0.001$), physical ($r = 0.35$, $P = 0.01$) and emotional ($r = 0.38$, $P = 0.01$) functions. At the end of RT, a multivariate analysis considering nutritional parameters and symptoms as the independent variables and QoL dimensions as the dependent variables, nutritional intake was identified as the only variable associated with global QoL ($P = 0.001$), physical ($P = 0.03$), role ($P = 0.01$) and emotional ($P = 0.04$) functions, and pain/discomfort was only associated with increased severity of symptoms ($P = 0.001$). The increase registered in each patients' nutritional intake was correlated with the increase of global QoL ($r = 0.78$, $P = 0.001$), physical ($r = 0.68$, $P = 0.002$) and emotional ($r = 0.67$, $P = 0.002$) functions (Pearson' method), which indicates that the patients who improved their energy intake also enhanced QoL dimensions.

In LR patients, nutritional parameters were not significantly associated with QoL dimensions.

4. Discussion

Nutrition is a key issue in oncology; nutritional decline ensues from the disease course and its treatment(s) [5,29]. Although the clinical manifestations of radiation injury and its nutritional consequences have been well described [3], to date there are no data on the role of routine adjuvant oral nutritional support in patients' outcomes, e.g. nutritional status and intake or QoL. This prospective study provides evidence that early individualised nutritional counselling improves patients' nutritional parameters and QoL.

Malnutrition was prevalent amongst HR patients, oesophagus, stomach and HN cancer, and rare in LR patients, in whom severe malnutrition was never observed, thus stressing the major role of cancer location, as previously reported [9,16]. Further on, the severity and extent to which patients experience side effects of RT depend on the tumour/treatment site, total dose, fractionation, volume of irradiated organ and injury repair mechanisms; high turnover cells, e.g. GI tract, are the most susceptible to acute radiation damage [3]. In our study, RT-induced symptoms affecting nutrient intake, such as dysphagia, mucositis, xerostomia, taste changes, diarrhoea, anorexia and nausea became evident only in HR patients. Our results corroborate that anorexia and nausea occur as a manifestation of the systemic tumour effect but their

incidence increase dramatically as a consequence of RT [17]. Albeit, although baseline nutritional intake in HR patients was significantly lower than EER, it did increase significantly as a result of the individualised nutritional counselling (as patients spontaneously acknowledged), hence overcoming the previous energy deficit; only two of the LR patients reported diarrhoea or anorexia, intake remained adequate and stable. Both oesophageal and stomach cancer patients reported a similar increase of ±280 kcal, lower than the observed in CR and HN cancer patients, ±460 kcal ($P = 0.03$). HR patients' baseline protein intake was also lower than requirements (NS) and than LR patients' ($P = 0.003$); nutritional counselling did improve protein intake to a still inadequate amount (NS). These data support the concept of cancer patients' aversion to protein dense foods, namely meat, further aggravated by RT [18]. Our results clearly show that individualised nutritional counselling based on each patient clinical condition, reported symptoms and nutritional status, is able to overcome the predicted deterioration subsequent to the increased severity of RT side effects; yet only HR patients appear to benefit.

Besides the site-specific RT effects, patients experience fatigue, anorexia and emotional stress, which may influence nutritional intake and QoL [6,22]. QoL assessment measuring the patients' experiences of the impact of disease/therapy, expectations and satisfaction should be the gold standard as an independent end-point in most clinical trials [27,31]. In the context of this prospective interventional study, we chose to test two QoL assessment instruments, in order to investigate their feasibility considering time of completion. Both, organised in distinct scales and items but somewhat covering similar dimensions, identified nutrition as one of the patients' major worries, further emphasised by the associations between nutritional parameters and QoL. The EUROQOL instrument disclosed worse QoL in HR patients, namely oesophageal, stomach or HN cancer, both at baseline and at the end of RT ($P = 0.001$). However, with the exception of symptom-induced pain/discomfort, and by contrast with LR patients, HR patients reported a significant improvement in all QoL dimensions at the end of RT. Although some data suggest an association between worse well being/morbidity and poor nutritional parameters [15], their relationship with QoL is widely underestimated [30]; two articles have addressed the value of artificial nutritional support on patients' nutritional status and QoL [24,28]. We have shown for the first time that, in HR diagnoses poorer nutritional status and intake were associated with worse mobility, limited usual activities and increased anxiety/depression. The improvement of the patient's nutritional intake was correlated with the reported improvement of QoL dimensions throughout RT. On the other hand, QoL dimensions scores were always much better in LR patients, likewise nutritional aspects were better, and not different, at both evaluation set points.

Baseline mean self-rated health status (SRHS), i.e. the patients' perception of their overall health [2] was also better in LR. Worse SRHS in HR patients was associated with poorer nutritional status and intake; although by univariate analysis, a better final nutritional status was associated with higher QoL ($P = 0.03$), the use of multivariate analysis disclosed the single significant association between final SRHS and nutritional intake ($P = 0.001$). Moreover, in spite of marked RT-induced symptoms, all HR patients did show a significant increase in their SRHS, which was correlated with improved nutritional intake ($P = 0.001$). In LR patients, the slight SRHS improvement was independent of nutritional intake. Our findings in HR patients reveal that a successful nutritional counselling and monitoring play an important role in QoL maintenance and/or improvement.

The EORTC instrument [1] disclosed overall similar QoL results: HR patients self-reported worse QoL, more evident in oesophageal, stomach and HN cancer, when compared with LR patients. At baseline, only in the HR group nutritional parameters did affect QoL components; malnutrition was associated with worse function scales as well as with poor appetite and increased fatigue. Poor scores in the latter two, along with worse global QoL, physical and emotional function scales were associated with low energy intake. At the end of RT, HR patients reported a higher QoL improvement, significant for all function scales, whilst LR patients only reported an increase in their global QoL without deterioration in any QoL dimension. HR patients worsened their symptom scales and single items, statistically significant for self-reported pain, nausea/vomiting and appetite; pain/discomfort was only associated with increased severity of symptoms ($P = 0.001$). By multivariate analysis, nutritional intake improvement was the only variable associated with final global QoL ($P = 0.001$), physical ($P = 0.03$), role ($P = 0.01$) and emotional ($P = 0.04$) functions. As observed with the EUROQOL instrument, patients who improved their intake also enhanced their QoL dimensions.

The results of both instruments showed that nutrition care does play a major role in the improvement of HR patients' QoL, despite the expected detrimental effects of RT [6,22]. Our results agree with the Keys et al. landmark study on human semi-starvation, which clearly demonstrated that psychological and functional improvements are early responses to nutritional intake increase [14].

The EUROQOL instrument describes health-related QoL according to five global domains; its completion is significantly shorter and less time consuming, on average 5 ± 2 min. The EORTC QLQ C-30 instrument covers more items and scales, identifies more domains and specific complaints, and hence is more comprehensive and time consuming, on average 13 ± 3 min. Both instruments were able to assess patients' QoL; in the context of this study both revealed the relevance of nutrition care. The EUROQOL instrument should be used as a routine in such patients, since quality of life is a major outcome [27,31]. The EORTC

QLQC-30 is more sensible, since it and covers more domains and assesses cancer and RT-specific symptoms. Time permitting, it should be used in routine clinical practice. The QoL instrument to use must be decided within the context of each clinical study/practice.

Cancer patients are at nutritional risk to be evaluated by a health care professional with nutrition expertise [1]. His/her integration in the multidisciplinary management allows a proper assessment of nutritional status and requirements, early nutritional counselling and monitoring of diet compliance enables timely adjustments according to symptoms. Our results show that, in patients prone to develop nutritional problems and to report the worst QoL, individualised nutritional counselling during radiotherapy is feasible and does improve nutritional intake that is identified as central to a better QoL. Early intervention and sensible partnership with patients are the keys to success.

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