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Abstract	This work aimed at evaluating patients' swallowing functions by a newly validated swallow-specific questionnaire, the Sydney Swallow Questionnaire (SSQ), in a cohort of oral and oropharyngeal cancer patients. Mean/median SSQ scores were calculated and compared with study variables using the Mann–Whitney U test and Kruskal–Wallis test. The mean composite SSQ scores (SD) for the base of tongue, oral tongue, and tonsillar cancer patients were 663.8 (382.8), 456.2 (407.6), and 283.0 (243.1), respectively ($p = 0.005$); for advanced vs. early T stage disease they were 918.1 (319.5) vs. 344.8 (292.1) ($p \leq 0.001$); for patients <60 years vs. ≥60 years they were 549.3 (415.1) vs. 314.0 (247.3) ($p = 0.02$); and for patients with reconstruction vs. without reconstruction they were 676.5 (410.5) vs. 331.9 (286.5) ($p = 0.002$). SSQ is a useful tool for evaluation of swallowing in head and neck cancer patients. Site of cancer, T stage, patient's age, and reconstruction directly affect post-treatment swallow outcome.

Keywords (separated by '-')	Swallowing - Deglutition - Head and neck cancer - Deglutition disorders - Sydney Swallow Questionnaire - SSQ - Oral cancer - Oropharyngeal cancer
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ORIGINAL ARTICLE

Evaluation of Swallowing by Sydney Swallow Questionnaire (SSQ) in Oral and Oropharyngeal Cancer Patients Treated with Primary Surgery

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Abstract This work aimed at evaluating patients' swallowing functions by a newly validated swallow-specific questionnaire, the Sydney Swallow Questionnaire (SSQ), in a cohort of oral and oropharyngeal cancer patients. Mean/median SSQ scores were calculated and compared with study variables using the Mann–Whitney U test and Kruskal–Wallis test. The mean composite SSQ scores (SD) for the base of tongue, oral tongue, and tonsillar cancer patients were 663.8 (382.8), 456.2 (407.6), and 283.0 (243.1), respectively ($p = 0.005$); for advanced vs. early T stage disease they were 918.1 (319.5) vs. 344.8 (292.1) ($p \leq 0.001$); for patients <60 years vs. ≥60 years they were 549.3 (415.1) vs. 314.0 (247.3) ($p = 0.02$); and for patients with reconstruction vs. without reconstruction they were 676.5 (410.5) vs. 331.9 (286.5) ($p = 0.002$). SSQ is a useful tool for evaluation of swallowing in head and neck cancer patients. Site of cancer, T stage, patient's age, and reconstruction directly affect post-treatment swallow outcome.

Keywords Swallowing · Deglutition · Head and neck cancer · Deglutition disorders · Sydney Swallow Questionnaire · SSQ · Oral cancer · Oropharyngeal cancer

Introduction

Swallowing is a complex process that depends on highly patterned neural and muscular control [1]. Because of the location of tumours within or near the important neuromuscular structures, the tumours themselves or the treatment of them can potentially affect swallowing function. It is noted in recent reports that up to 75% of head and neck cancer (HNC) patients may complain of swallowing problems in the post-treatment period [1–4].

Functional impairments of the swallowing process in HNC patients have been studied and reported in the past using different instruments like videofluoroscopy (VF), fibreoptic endoscopic evaluation of swallowing (FEES) [1], and/or validated head and neck–specific questionnaires such as the University of Washington Quality of Life (UWQOL) questionnaire [5], the European Organization for Research and Treatment of Cancer Head and Neck module (EORTC-H&N) [6], the Functional Assessment of Cancer Therapy-Head and Neck (FACT-H&N) questionnaire [7], or validated symptom-specific tools like the MD Anderson Dysphagia Inventory (MDADI) [8], Performance Status Scale for head and neck cancer patients (PSS-HN) [9], and the swallowing quality-of-life instrument (SWAL-QOL) [10]. Instrumental assessment of swallowing function requires additional resources, like instruments and

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experts, or extra time, all of which increase the cost of the treatment and become a burden on health-care facilities. Also, not every HNC patient requires instrumental assessment of swallow function.

Since swallowing impairment is a common occurrence in HNC patients, there is a need for a mechanism by which patients can be screened and evaluated to detect and document swallowing problems, and those with impairment can be further evaluated by instrumental methods. The available HNC-specific questionnaires evaluate swallowing as part of the assessment of quality of life (QOL) as a whole and, as such, contain fewer than five questions devoted to swallow evaluation. This is insufficient considering the highly complex nature of this function. On the other hand, the most widely used swallow-specific questionnaires like MDADI and the SWAL-QOL also follow the same path of evaluating the QOL and the number of swallow function–specific questions included in them is 8 (of 20) and 14 (of 44), respectively. Although SWAL-QOL is promoted as the most comprehensive swallow-specific questionnaire to date, its length and the time taken to complete it (ca. 20 min) makes it practically difficult to use in most clinical settings. To overcome these problems, a new patient-reported swallow function–specific evaluation tool, the Sydney Swallow Questionnaire (SSQ), has been recently validated for use in HNC patients [1].

The aim of this study was to evaluate swallowing functions using the Sydney Swallow Questionnaire [11] in our cohort of oral cavity (OC) and oropharyngeal (OP) cancer patients treated with primary surgery. This is the first study to use SSQ in an HNC patient population. An attempt has also been made to explore factors that affect swallow functions in OC and OP cancer patients.

Materials and Methods

Patients

The study was approved by the local research and ethics committee. For this cross-sectional study, 62 consecutive follow-up OC and OP cancer patients were recruited at The Royal Marsden Hospital. All patients had been treated by primary surgery with curative intent. Some patients had received additional radiotherapy (RT) or chemoradiotherapy (CRT), depending on the nature of the disease. Patients with end-stage OC or OP cancer, other associated cancers, and underlying diagnosed neuromuscular disorders that may have affected swallowing functions were excluded from the study. Patients within the first 6 months of finishing treatment, patients over 80 years of age, and those with feeding gastrostomy or jejunostomy were also excluded from the study.

Instrument

The Sydney Swallow Questionnaire is a tool specifically designed for evaluation of swallowing difficulties in neuromyogenic, oropharyngeal dysphagia patients [11]. The tool was validated for use in HNC patients by our group [1]. The SSQ consists of 17 well-structured questions (Table 1) for the assessment and quantification of patient-reported difficulties in swallowing function. The tool is specifically designed to evaluate important aspects of swallowing function and is distinctively directed towards oral and pharyngeal phase impairments [1, 11]. The questions cover the symptoms related to combinations of variables like the anatomic region, type of dysfunction, and the consistency of swallowed bolus. Questions regarding swallowing dysfunction associated with different consistencies of bolus are included because the response to swallowing difficulties varies with anatomical subsite and bolus consistency [12]. The total time required by patients to complete this questionnaire is less than 10 min. The individual question scores are calculated on a 100-mm visual analogue scale. The total score is calculated by summing the individual responses; a higher score indicates a more severe swallowing impairment. Please refer to the index paper for the details of SSQ [11].

Administration of the SSQ

The SSQ was given to patients in the outpatient clinic with a personalized cover letter explaining briefly the purpose of the study. The questionnaire and the purpose of study were also explained to each patient face to face. The patients were asked to complete the SSQ and return by post within 2 weeks.

Statistical Analysis

The medical records of all patients were retrospectively reviewed for clinicodemographic variables and the data were extracted and entered into a worksheet (Excel 05, Microsoft Corp., Redmond, WA, USA). Similarly, questionnaire data were also entered in the worksheet for analysis, which was performed using the commercially available Statistical Package for Social Sciences-15 (SPSS Inc., Chicago, IL, USA). The individual question results as well as the composite scores for the SSQ were non-normally distributed; hence, the results of the individual questions were calculated as median and range. The Mann–Whitney U-test was used for comparing two patient subgroups and the Kruskal–Wallis test was used for comparing three or more subgroups against the study variables. The level of significance was set at $p \leq 0.02$ after appropriate adjustments for multiple comparisons.

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Table 1 Layout of the component questions of the Sydney Swallow Questionnaire

SN	Question
Question 1	How much difficulty do you have swallowing at present?
Question 2	How much difficulty do you have swallowing THIN liquids? (e.g., tea, soft drink, beer, coffee)
Question 3	How much difficulty do you have swallowing THICK liquids? (e.g., milkshakes, soups, custard)
Question 4	How much difficulty do you have swallowing SOFT foods? (e.g., mornays, scrambled egg, mashed potato)
Question 5	How much difficulty do you have swallowing HARD foods? (e.g., steak, raw fruit, raw vegetables)
Question 6	How much difficulty do you have swallowing DRY foods? (e.g., bread, biscuits, nuts)
Question 7	Do you have any difficulty swallowing your saliva?
Question 8	Do you ever have difficulty starting a swallow?
Question 9	Do you ever have a feeling of food getting stuck in the throat when you swallow?
Question 10	Do you ever cough or choke when swallowing solid foods? (e.g., bread, meat, or fruit)
Question 11	Do you ever cough or choke when swallowing liquids? (e.g., coffee, tea, beer)
Question 12*	How long does it take you to eat an average meal?*
Question 13	When you swallow does food or liquid ever go up behind your nose or come out of your nose?
Question 14	Do you ever need to swallow more than once for food to go down?
Question 15	Do you ever cough up or spit out food or liquids DURING a meal?
Question 16	How do you rate the severity of your swallowing problem today?
Question 17	How much does your swallowing problem interfere with your enjoyment or quality of life?

All questions except Question 12 are answered on a visual analogue scale under each response

* Possible responses for this question are 15 min, 15–30 min, 30–45 min, 45–50 min, 60 min, and "unable to swallow at all"

Results

Demographics

The response rate of the study was 87% as 54 of 62 patients returned an adequately completed questionnaire for tabulation and analysis. The cohort consisted of 35 male and 19 female patients with the mean age (SD) of 58.6 (9.7) years. The primary site of cancer was the oral cavity in 29.6% of patients and the oropharynx in 70.4%. The detailed patient characteristics are provided in Table 2.

Swallowing Function

OC cancer patients perceived the most difficulty in swallowing hard and dry foods, with median scores (range) of 51 (3–100) and 49 (3–100), respectively (Fig. 1). Swallowing-related quality of life, 25.5 (2–100); severity of the problem at the time of assessment, 20.0 (1–100); length of time taken to eat an average meal, 20.0 (0–100); coughing or choking while swallowing solid foods, 16.5 (2–100); food getting stuck in the throat, 14.4 (1–100); need to swallow more than once, 14.5 (0–100); overall swallowing at the time of assessment, 13.0 (3–100); coughing up or spiting out the liquid or food during meals, 11.0 (2–100); difficulty in starting the swallow, 10.5 (1–74); and coughing or choking while swallowing liquids, 10.5 (2–100), were the main concerns for OC cancer patients (Fig. 1). Some other issues perceived by these patients were difficulty in swallowing their own saliva, 9.5 (3–98); difficulty in swallowing soft food, 6.5 (0–100); and difficulty in swallowing thin liquids, 5.5 (0–100). Nasal regurgitation of food, 4.5 (0–30) and difficulty in swallowing thick liquids, 4.0 (3–100), were the least commonly perceived problems by this group (Fig. 1).

For OP cancer patients issues with swallowing dry food, food getting stuck, swallowing hard food, and coughing or choking with solid food were the most commonly perceived problems, with median scores (range) of 52.0 (0–100), 28.0 (0–100), 27.0 (0–100), and 20.5 (0–97), respectively (Fig. 2). Length of time taken to eat an average meal, coughing up or spitting out the liquid or food during meals, overall swallowing at the time of assessment, swallowing more than once, coughing or choking while

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Table 2 Patient characteristics ($N = 54$)

Characteristic	Number (%)
Age (years) [mean (SD)]	58.6 (9.7)
Sex	
Male	35 (64.8)
Female	19 (35.2)
Tumour location	
Oral cavity	16 (29.6)
Oropharynx	38 (70.4)
Tumour location (subsite)	
Oral tongue	14 (25.9)
Base of tongue	15 (27.8)
Floor of mouth	2 (3.7)
Tonsil	22 (40.7)
Soft palate	1 (1.9)
T stage	
T1	15 (27.8)
T2	30 (55.6)
T3	4 (7.4)
T4	5 (9.3)
Clinical stage	
I	7 (13.0)
II	5 (9.3)
III	8 (14.8)
IV	34 (63.0)
N stage	
N0	16 (29.6)
N1	6 (11.1)
N2	31 (57.4)
N3	1 (1.9)
Treatment	
Surgery alone	6 (11.1)
Surgery + postoperative radiotherapy (PORT)	26 (48.1)
Surgery + postoperative chemoradiotherapy (POCRT)	22 (40.7)
Follow-up (months) [mean (SD)]	76.4 (58.6)

swallowing liquids, difficulty in starting a swallow, severity of swallowing problem on the day of assessment, difficulty in swallowing their own saliva, difficulty in swallowing soft foods, and the QOL were also a concern as perceived by these patients, with mean scores (range) of 20.0 (0–60), 19.1 (0–98), 18.0 (0–95), 17.0 (0–100), 15.5 (0–94), 14.5 (0–100), 14.0 (0–97), 11.0 (0–100), 9.0 (0–78), and 7.5 (0–95), respectively (Fig. 2). Nasal regurgitation of foods and liquids and difficulty in swallowing thick liquids and thin liquids were the least commonly perceived swallowing-related concerns of these patients, with median scores (range) of 3.5 (0–87), 3.0 (0–78), and 3.0 (0–65), respectively (Fig. 2).

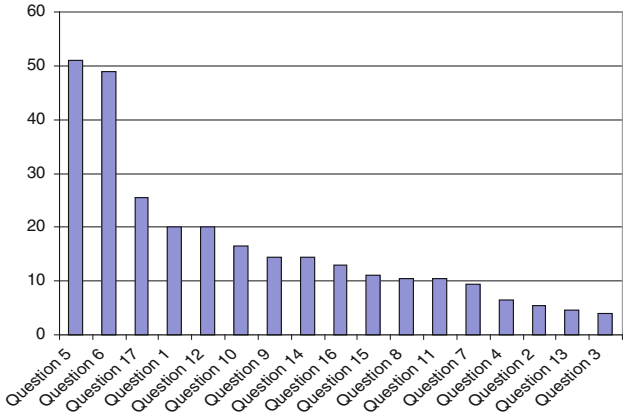

Fig. 1 Median scores of individual swallowing impairments (based on the SSQ) in oral cancer patients

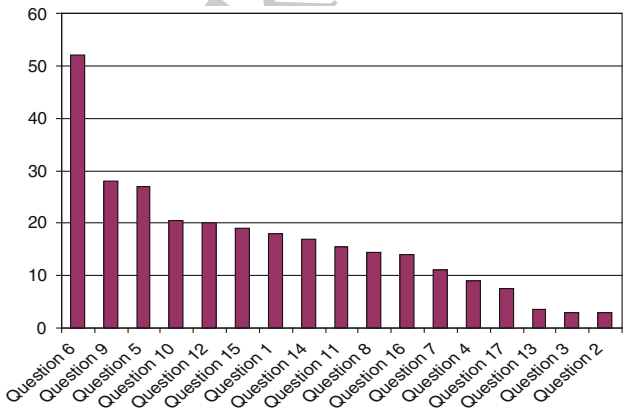

Fig. 2 Median scores of individual swallowing impairments (based on the SSQ) as perceived by oropharyngeal cancer patients

Clinicodemographic Variables

The mean composite SSQ scores (SD) for OC and OP cancer patients were 453.3 (403) and 434.9 (352.4), respectively. The base-of-tongue (BOT) cancer patients reported significantly higher mean SSQ scores compared to patients with cancer of the oral tongue or tonsil, of which the former indicate poor swallow functions. The mean SSQ scores (SD) were 663.8 (382.8) vs. 456.2 (407.6) and 283.0 (243.1), respectively ($p = 0.005$) (Table 3). Significantly higher mean SSQ scores (SD) were noted in patients with advanced T stage (T3/T4) disease compared to patients with early T stage (T1/T2) disease, i.e., 918.1 (319.5) vs. 344.8 (292.1) ($p < 0.001$). Younger patients (<60 years) reported significantly higher mean SSQ scores (SD) than older patients (≥60 years), i.e., 549.3 (415.1) vs. 314.0 (247.3) ($p = 0.02$). Patients who underwent reconstruction following tumor resection also had significantly higher mean SSQ scores than those without reconstruction, i.e., 676.5 (410.5) vs. 331.9 (286.5) ($p = 0.002$) (Table 3).

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Table 3 Mean composite score and study variables ($N = 54$)

Variable	No. of patients	Mean total SSQ Score (SD)	p
Site			
Oral cavity	16	**453.3 (403)**	1.0
Oropharynx	38	**434.9 (352.4)**	
Subsite			
Oral tongue	14	**456.2 (407.6)**	**0.005***
Base of tongue	15	**663.8 (382.8)**	
Tonsil	22	**283 (243.1)**	
T stage			
Early (T1/T2)	45	**344.8 (292.1)**	**<0.001***
Late (T3/T4)	9	**918.1 (319.5)**	
Age group			
<60 years	29	**549.3 (415.1)**	**0.02***
≥60 years	25	**314 (247.3)**	
Sex			
Male	35	**416.4 (343)**	0.67
Female	19	**484.5 (406.7)**	
Follow-up			
<2 years	11	**259.5 (256.7)**	0.033
≥2 years	43	**486.7 (375.5)**	
Type of treatment			
Surgery alone	6	**277.3 (264)**	0.46
Surgery + PORT	26	**436.7 (330.8)**	
Surgery + POCRT	22	**489.2 (421.9)**	
Reconstruction			
No	37	**331.9 (286.5)**	**0.002***
Yes	17	**676.5 (410.5)**	

PORT Postoperative radiotherapy, *POCRT* postoperative chemoradiotherapy

* $p \leq 0.02$ from the Mann–Whitney U test (for two patient subgroups) and the Kruskal–Wallis test (three or more subgroups)

Discussion

During normal swallowing, muscle groups act as agonists and antagonists or synergists and cocontractors and these coordinated, dynamic forces control the stimulus that is food and drink [13]. After surgical resection of oral and/or oropharyngeal cancer, weakness and reduced range of motion can occur. Any alteration in muscle function can decrease the effective motion or impair the stabilization of the suprahyoid structures. Subsequently, the degree of preparation and the quality of control in the oral phase may be reduced [14, 15], which may be responsible for poor preparation of the food bolus and ultimately result in difficulty in swallowing, especially dry and hard food. In addition, inadequate preparation of the food bolus can lead to a compensatory increase in the time required for a single swallow as well as the total time required to eat a meal. Such findings were very much evident by the higher median SSQ scores in both OC and OP cancer patients (Figs. 1 and 2). Reduced saliva production subsequent to RT or CRT can further augment [16–19] already compromised preparatory and oral phases in these patients.

Modification of the orientation of muscle fibres as seen after tumor resection or reconstruction can affect synchronized movement and cause paradoxical movements to occur. Such movements can result in difficulty in manipulating and transferring the food bolus in the posterior direction [13]. Reduced control at this level also has a significant impact on the lower swallow-related structures because the pharyngeal phase requires the oral phase to deliver the bolus at the appropriate time and with adequate force. Impaired bolus propulsion can result in reduced coordination between the oral and pharyngeal phases [13]. This incoordination may lead to coughing and choking while swallowing solid foods and gives a feeling of food sticking in the throat (incomplete swallow), which may require multiple swallows in order to swallow a bolus. This possibility is borne out by the high median SSQ scores for individual functions in the present study. Reduced force at the base-of-tongue region may lead to difficulty in initiating the swallow and further increase the time taken, strength, and quality of the swallow. Again, this possibility is mirrored by the high median SSQ scores in both OC and OP cancer patients in this study. Muscle force is also necessary for sufficient movement of swallowing structures, like elevation of the velum and the larynx and the contraction of the pharyngeal constrictors (superior, middle, and inferior) to prevent nasal regurgitation and laryngeal aspiration, respectively [13].

The interconnected structures of the tongue, hyoid, and larynx work together as a system for motion and support. When the muscle groups between the tongue and the hyoid are altered, laryngeal motion during swallowing may be affected [13]. Also, when the muscles involved in laryngeal elevation are disturbed, the duration and diameter of the opening of the cricopharyngeal sphincter are affected because they are related to the height and duration of laryngeal elevation [13]. All these factors may result in aspiration of the patient's saliva, food, or liquids. Dysfunction at the level of the cricopharyngeal sphincter can also result in residue within the pyriform sinus and this may subsequently be aspirated. Loss or reduction of sensation, as may be seen after surgery, radiotherapy, or chemotherapy, may diminish coordinated movements and may limit the patient's motor problem-solving ability [13]. The slowness is often the result of reduced motor coordination rather than sensory deficit; higher-viscosity foods pose maximum risk as they increase oral and pharyngeal transit times as well as the duration of pharyngeal constriction. This was very much evident by the relatively low

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median SSQ scores for respective functions in the present study. Decreased saliva secretion as a consequence of RT may have a compounding effect.

Swallow function in OC and OP cancer patients may be affected by several disease factors, patient factors, and treatment factors. The present SSQ study pointed out that the location of cancer within the OC or OP can be a major determinant in predicting post-treatment swallowing impairments. Patients who had cancer in the base-of-tongue region had significantly worse swallow function, as evident by the higher mean SSQ scores compared to patients with tonsillar cancers. As mentioned above, the BOT region is the most important area responsible for normal swallow function [20], followed by the oral tongue, so it is understandable that any insult to these regions will ultimately translate into poor swallow function. We also found that patients presenting with advanced T stage (T3/T4) cancer had significantly worse swallow function than patients with early T stage (T1/T2) disease. This is probably because advanced T stage patients often require larger resections and multiple procedures such as neck dissection and reconstruction and may also have received RT or CRT as adjunctive treatment. All of these factors may have worked together to compromise swallowing function. This is particularly important for patients who had RT as part of treatment protocol because late-stage postradiation fibrosis is a known cause of swallowing impairments in these patients. The age of the patients also emerged as an important determinant of post-treatment swallowing function in OC and OP cancer patients. It is generally thought that older patients will have more swallowing-related problems than younger patients because of age-related neuromuscular incoordination. Conversely, in this study, the mean SSQ scores were higher for younger patients (<60 years), indicating that they perceived more swallowing-related problems. This may be explained by higher expectations for recovery in younger patients.

Reconstruction is yet another factor that may affect swallow functions in OC and OP cancer patients. The reported mean SSQ scores were significantly higher for patients who underwent reconstruction for the closure of the defect than for those in whom the defect was closed primarily or left to heal by secondary intention. This may be explained by the fact that flaps can provide a cover and mass but hinder movement, force of contraction, and sensation which may result in incoordination and destabilization of oral and pharyngeal phases of the swallow. This situation may be responsible for poor bolus control, inadequate swallow, and more swallowing problems in these patients, as discussed above. The flaps are usually bulky, akinetic, and nonsensate and, therefore, the decision regarding their use for reconstruction of defects requires caution, particularly for oral tongue or BOT cancer. We should try to adopt a conservative approach in using reconstruction, especially for oral tongue cancers for which nowadays there is a trend toward using radial forearm free flaps for almost all defects. It should be borne in mind that a short/less bulky but mobile and sensate tongue may provide better swallowing function in these patients than a bulky nonfunctional and nonsensate tongue [2, 21, 22].

The present study shares some inherent limitations of any cross-sectional study involving retrospective evaluation of clinical records. Also, ours is a tertiary cancer care centre and caters mainly to referred patients; hence, the number of patients is relatively small and there may be a chance of selection bias. We tried to minimize this risk by recruiting consecutive patients in this study.

Conclusion

The Sydney Swallow Questionnaire is a useful tool in the evaluation of patient-reported severity of swallowing function. We believe that the SSQ will be a valuable aid in the evaluation and management of dysphagia in OC and OP cancer patients and will help in the rehabilitation of HNC patients. We also found that the severity of swallowing impairment in OC and OP cancer patients is directly related to the site and T stage of the cancer, the age of the patient, and the use of surgical reconstruction. It will be important to use SSQ in future prospective studies in order to gain a clearer picture of its potential role in this patient population.

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Conflict of interest None.

Ethical approval The study was approved by the Royal Marsden Research Ethics Committee.

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