

An exploratory study of the influence of clinico-demographic variables on swallowing and swallowing-related quality of life in a cohort of oral and oropharyngeal cancer patients treated with primary surgery

Raghav C. Dwivedi · Edward J. Chisholm · Afroze S. Khan · Nicholas J. Harris ·
Shree A. Bhide · Suzanne St.Rose · Cyrus J. Kerawala · Peter M. Clarke ·
Christopher M. Nutting · Peter H. Rhys-Evans · Kevin J. Harrington · Rehan Kazi

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Abstract There are insufficient data on swallowing and the consequences of its dysfunction in patients with cancers of the oral cavity (OC) and oropharynx (OP) that are treated with primary surgery. The study attempts to explore the effect of important clinico-demographic variables on post-treatment swallowing and related quality of life (QOL) in post-surgical OC and OP cancer patients. Sixty-two consecutive OC and OP cancer patients completed the MD Anderson Dysphagia Inventory (MDADI) questionnaire. Mean scores were computed. Comparison of scores based on mean ranks were performed using Mann–Whitney *U* test or Kruskal–Wallis test. Level of significance was set at $P \leq 0.02$. Adjustments were made for multiple comparisons. Significantly worse mean (SD) QOL scores were observed in late T-stage (T3/T4) versus early T-stage (T1/T2) patients for global domain, physical domain, functional domain and emotional domains [44.4 (21.9) vs. 78.7 (22.7) ($P < 0.001$); 50.0 (9.4) vs. 75.9 (16.3), ($P < 0.0001$);

57.8 (20.6) vs. 84.1 (16.7), ($P < 0.001$) and 55.2 (18.0) vs. 78.5 (16.3), ($P < 0.001$)], respectively. Patients undergoing reconstruction versus without reconstruction had worse QOL scores; 58.8 (26.9) versus 79.5 (22.8), ($P < 0.01$); 61.2 (15.1) versus 76.4 (17.5), ($P = 0.002$); 65.4 (20.5) versus 86.3 (15.9), ($P < 0.0001$) and 63.3 (18.8) versus 79.8 (16.3), ($P < 0.01$), respectively, for global, physical, functional and emotional domains. Advanced T-stage, reconstruction, younger age and base of tongue tumours have a negative impact on post-treatment swallow function and related QOL in these patients.

Keywords Swallowing · Quality of life · Oral cancer · Oropharyngeal cancer · Head and neck cancer · Questionnaire · MDADI

Introduction

Functional impairment of swallowing is often seen in head and neck cancer (HNC) patients, and is known to result in a poor quality of life (QOL) [1–5]. According to the recent estimates, as many as 50–75% of HNC survivors report some degree of swallowing difficulties [6–8]. The normal swallow is a quick, dynamic and complex function which requires the synchronized action of several muscles and nerves located within the head and neck region [1]. Most of these are either located in or near the oral cavity (OC) and oropharynx (OP). Understandably, cancer of the OC and the OP and its treatment may affect swallowing function to a greater extent than any other HNC [6]. The recovery may be slow and, even with intensive therapeutic input, often remains incomplete [9].

The evaluation of swallowing is commonly done by the videofluoroscopy/modified barium swallow (MBS) studies

R. C. Dwivedi (✉) · E. J. Chisholm · A. S. Khan · S. A. Bhide ·
C. J. Kerawala · P. M. Clarke · C. M. Nutting · P. H. Rhys-Evans ·
K. J. Harrington · R. Kazi
Head and Neck Unit, Royal Marsden Hospital,
Fulham Road, London SW3 6JJ, UK
e-mail: raghav_dwivedi@rediffmail.com

R. C. Dwivedi · S. A. Bhide · C. M. Nutting ·
P. H. Rhys-Evans · K. J. Harrington · R. Kazi
The Institute of Cancer Research, 237 Fulham Road,
London SW3 6JB, UK

R. C. Dwivedi · N. J. Harris
Department of ENT and Head-Neck Surgery,
Whipps Cross University Hospital, London E11 1NR, UK

S. St.Rose
Research, Data and Statistical Unit, Royal Marsden Hospital,
Fulham Road, London SW3 6JJ, UK

or by fibre optic endoscopic evaluation of swallowing (FEES) [1]. This allows anatomic and physiologic details of the swallow function from a clinician's point of view. However, it is also important to know how the patients are affected by the compromised swallow and how and to what extent they adapt to this problem. Patients' account of their swallow function and related effects can be obtained by patient self-reported symptom-specific questionnaires like MD Anderson Dysphagia Inventory (MDADI) [10], Performance Status Scale for head and neck cancer patients (PSS-HN) [11] or swallowing-quality-of-life-instrument (SWAL-QOL) questionnaire [12].

The outcomes in cancers of the OC and OP depend on several variables specific to the cancer (site, sub-site, size), the patient (age, gender) and the clinician (choice of modality, extent of therapy). A detailed understanding of these variables can help in deciding the most appropriate treatment plan for individual patients so as to maximize survival and optimize functional outcomes. The effect of the different clinico-demographic variables on post-treatment swallowing outcomes and related QOL has been reported in a patchy fashion thus far in the literature. In addition, there is paucity of data on swallowing as a function per se and the functional effects of aberrant swallowing in OC and OP cancer patients [2]. The aim of this study was to evaluate the usefulness of the MDADI in exploring some of these variables and their effect on post-treatment swallowing function and related QOL in OC and OP cancer patients treated primarily with surgery.

Materials and methods

Patients

Sixty-two consecutive, follow-up, OC and OP cancer patients at The Royal Marsden Hospital, London, UK were recruited for the study. All patients had received treatment in the form of primary surgery with a curative intent \pm post-operative radiotherapy/chemoradiotherapy. Patients with any diagnosed neuromuscular condition known to affect swallowing function, other associated malignancies, patients with end-stage disease and patients over 80 years of age were excluded from the study. Patients with feeding gastrostomy or jejunostomy and patients within the first 6 months of initial treatment were also excluded.

The instrument

The MDADI was used as a gold-standard swallow function and swallowing-related QOL outcome assessment scale. It is a well-validated, widely used, self-administered questionnaire

with 20 well-constructed questions for the evaluation of the patient's perception over four varied domains of swallowing-related QOL: Global (G), Physical (P), Functional (F) and Emotional (E) [10].

Scoring of the instrument

For every question on the MDADI scale, five possible responses were possible (strongly agree, agree, no opinion, disagree and strongly disagree) which were scored on a scale of 1–5. The questions regarding each aspect of dysphagia were summed, and a mean score was calculated. This mean score was multiplied by 20 to obtain a score with a range of 0 (extremely low functioning) to 100 (high functioning) [10]. Thus, a higher MDADI score represents better day-to-day function and better QOL [10]. Please see the index paper [10] for further details.

Administration of the questionnaire

The MDADI questionnaire was given to patients in the outpatient clinic with a personalized covering letter explaining briefly the purpose of the study. In addition, the questionnaire and the purpose of the study were explained face-to-face to each patient. Patients were invited to complete the questionnaire and return via post within a 2-week period.

Statistical analysis

Clinical records of all patients were retrospectively reviewed and relevant clinico-demographic details were extracted and entered into a worksheet (Excel 05; Microsoft Corp., WA, USA) along with the questionnaire data. All results were tabulated and sub-scale scores on the MDADI were compared between different clinico-demographic variables. Analysis was performed using the commercially available Statistical Package for Social Sciences-15 statistical software (SPSS Inc., Chicago, IL, USA). Since the distribution of the data was not normal, non-parametric tests were used. The Mann–Whitney *U* test and Kruskal–Wallis test were used for comparison of score data for two groups, or three or more groups of observations, respectively. Mean scores and associated standard deviations were presented. Level of significance was set at $P \leq 0.02$. Adjustments were made for multiple comparisons.

Results

Patient characteristics

We received 54 fully completed questionnaires from the initial cohort of 62 patients, thus providing a response rate

Table 1 Overview of patient characteristics ($n = 54$)

Characteristic	Number (%)
Age	
Mean (SD)	58.6 (9.7)
Gender	
Male	35 (64.8)
Female	19 (35.2)
Site of tumour	
Oral cavity	16 (29.6)
Oropharynx	38 (70.4)
Sub-site of tumour	
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 (55.5)
T3	4 (7.4)
T4	5 (9.3)
Clinical stage	
I	7 (13.0)
II	5 (9.3)
III	8 (14.8)
IV	34 (62.9)
N stage	
N0	16 (29.6)
N1	6 (11.1)
N2	31 (57.4)
N3	1 (1.9)
Treatment	
Sx alone	6 (11.1)
Sx + PORT	26 (48.2)
Sx + POCRT	22 (40.7)
Follow-up (months)	
Mean (SD)	76.4 (58.6)

Sx surgery, PORT post-operative radiotherapy, POCRT post-operative chemoradiotherapy

of 87%. The mean age (SD) of the group was 58.6 (9.7) years with 35 males and 19 females. Oral cavity was the site of cancer in 29.6% cases while 70.4% patients had a tumour of the oropharynx. A detailed description of the patient characteristics is provided in Table 1. Five out of nine late T (T3/T4) stage patients and 12 out of 45 patients with early T (T1/T2) stage cancer underwent reconstruction as a part of treatment of the primary cancer.

Swallowing data

The mean MDADI global QOL score (SD), physical domain score, functional domain and emotional domain

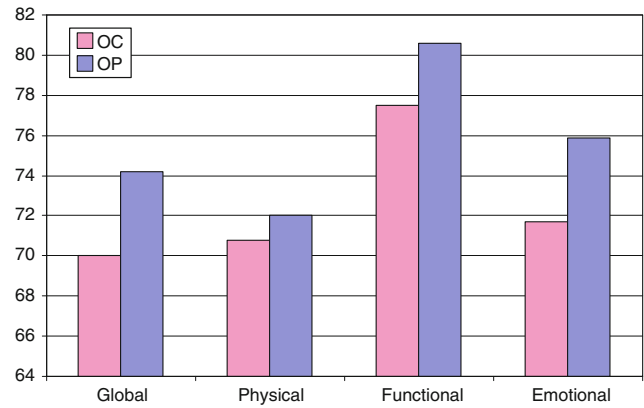


Fig. 1 Mean scores of different MDADI quality of life (QOL) domains for oral and oropharyngeal cancers patients

scores for the whole cohort were 72.9 (25.8), 71.6 (18.1), 79.7 (19.8) and 74.6 (18.6), respectively. The mean MDADI global QOL scores (SD) for the OC and OP whole cohort were 70.0 (28.3) and 74.2 (25), mean physical domain scores were 70.8 (17.6) and 72(18.5), mean functional domain scores were 77.5 (19.8) and 80.6 (19.8) and mean emotional domain scores were 71.7 (19.2) and 75.9 (18.5), respectively, Fig. 1; Table 2.

Significantly worse mean scores across all four domains (global, physical, functional and emotional) were noted in patients with late (T3/T4) versus early T stage (T1/T2), with mean (SD) scores of 44.4 (21.9) versus 78.7 (22.7) ($P < 0.001$); 50.0 (9.4) versus 75.9 (16.3), ($P < 0.0001$); 57.8 (20.6) versus 84.1 (16.7), ($P < 0.001$) and 55.2 (18.0) versus 78.5 (16.3), ($P < 0.001$), respectively, (Table 2).

Similarly patients undergoing reconstruction of the primary defect had significantly worse mean QOL scores compared to those who did not require any reconstructive procedure. The mean (SD) scores were 58.8 (26.9) versus 79.5 (22.8), ($P < 0.01$); 61.2 (15.1) versus 76.4 (17.5), ($P = 0.002$); 65.4 (20.5) versus 86.3 (15.9), ($P < 0.0001$) and 63.3 (18.8) versus 79.8 (16.3), ($P < 0.01$), respectively, for global, physical, functional and emotional domains of the swallow related QOL (Table 2).

Also significantly worse mean scores (SD) were noted in younger (less than 60 years) versus older patients (60 years or above) in the physical and emotional domains (Table 2). The mean (SD) scores for respective domains were 65.8 (19.3) versus 78.4 (14.2), ($P = 0.01$) and 68.3 (19.9) versus 82.0 (14.0), ($P < 0.01$).

Significantly worse mean scores were seen in patients with base of tongue cancers as compared to oral tongue or tonsillar cancer patients in functional domain, the values being 66.7 (21.6), 78.8 (18.6) and 90.0 (12.2), respectively, ($P < 0.01$) (Table 2).

Table 2 Mean domain scores and study variables

Variable	N	Global domain		Physical domain		Functional domain		Emotional domain	
		Mean score (SD)	P value	Mean score (SD)	P value	Mean score (SD)	P value	Mean score (SD)	P value
Site									
Oral cavity	16	70.0 (28.3)	0.72	70.8 (17.6)	0.71	77.5 (19.8)	0.64	71.7 (19.2)	0.57
Oropharynx	38	74.2 (25)		72 (18.5)		80.6 (19.8)		75.9 (18.5)	
Sub-site									
Oral tongue	14	70 (28)	0.07	70.4 (17.8)	0.03	78.8 (18.6)	<0.01*	71.9 (18.4)	0.09
Base of tongue	15	61.3 (24.5)		60 (15.1)		66.7 (21.6)		66.7 (20.6)	
Tonsil	22	82.7 (22.5)		79.8 (16.9)		90 (12.2)		82.3 (14.6)	
T stage									
Early (T1/T2)	45	78.7 (22.7)	<0.001*	75.9 (16.3)	<0.0001*	84.1 (16.7)	<0.001*	78.5 (16.3)	<0.001*
Late (T3/T4)	9	44.4 (21.9)		50 (9.4)		57.8 (20.6)		55.2 (18)	
Age group									
<60	29	66.2 (28.3)	0.06	65.8 (19.3)	0.01*	73.2 (23.0)	0.03	68.3 (19.9)	<0.01*
≥60	25	80.8 (20.4)		78.4 (14.2)		87.2 (12.0)		82 (14)	
Gender									
Male	35	74.3 (25)	0.62	72.6 (17.9)	0.62	80.4 (18.3)	0.84	77 (18.2)	0.33
Female	19	70.5 (27.8)		69.7 (18.9)		78.3 (23.0)		70.2 (19)	
Follow-up									
<2 years	11	83.6 (23.4)	0.07	80 (15.5)	0.10	84.0 (19)	0.37	78.2 (15.5)	0.47
≥2 years	43	70.2 (26)		69.5 (18.3)		78.6 (20.1)		73.7 (19.4)	
Type of treatment									
Sx alone	6	83.3 (23.4)	0.51	80.8 (16.9)	0.35	82.7 (22.1)	0.72	81.1 (18.2)	0.48
Sx + PORT	26	73.1 (24)		71.6 (16.9)		79.7 (19.5)		75.1 (19.1)	
Sx + POCRT	22	70 (28.8)		69.1 (19.7)		78.9 (20.5)		72.3 (18.5)	
Reconstruction									
No	37	79.5 (22.8)	<0.01*	76.4 (17.5)	0.002*	86.3 (15.9)	<0.0001*	79.8 (16.3)	<0.01*
Yes	17	58.8 (26.9)		61.2 (15.1)		65.4 (20.5)		63.3 (18.8)	

N number of patients, Sx surgery, PORT post-operative radiotherapy, POCRT post-operative chemoradiotherapy

* P value ≤ 0.02 from Mann–Whitney U test (for two patients subgroups) and from Kruskal–Wallis test (three or more subgroups)

Discussion

Deterioration of swallowing function is a key component that affects QOL in HNC patients [1–5]. This represents a significant concern for OC and OP cancer patients and must be addressed to improve the QOL [13]. In this study, we had a high response rate of participating patients, possibly indicating their interest in this area. Several validated questionnaires have been used in the past for assessment of swallow function and related QOL in HNC patients [1]. This study is the first to use the MDADI to assess swallowing function and swallowing-related QOL in an exploratory manner in a specified cohort of OC and OP cancer patients.

In general, good mean QOL scores were observed across the different QOL domains. The physical domain scores were lowest in these patients, followed closely by the global domain scores. This is reflective of patients' perceived difficulty of swallowing as a physiologic function, compared

to other domains of the swallowing-related QOL and its direct effect on overall QOL of these patients.

The anatomical location of the tumour may have an effect on swallowing function and swallowing-related QOL in patients. It is generally accepted that tumours arising in the OC and OP will have a greater impact on the swallow and, consequently, this group may expect a greater impact on QOL compared with other HNC sites. However, there are contradictory reports regarding the sub-sites within the OC and OP [6, 13–15]. In this study, the mean QOL scores were slightly better for OP than OC cancer patients, although this was not statistically significant. Furthermore sub-site analysis of the data showed differences among all four domains of the QOL construct; however, the results could reach the level of statistical significance for functional domain only (Table 2). Patients with base of tongue cancers reported consistently worse mean QOL scores across all four domains, followed by patients who had cancer

of the oral tongue. This affirms the predominant role of the tongue (especially the basal region) in swallowing function and its impact on patients' QOL. It is known that the base of tongue region plays a vital role in the propulsion of the bolus through the mouth and pharynx and is a major generator of pressure [16] in the oral and pharyngeal phase of swallowing and consequently its loss results in poor swallow function and a poor QOL. Among all the sub-sites, the best mean QOL scores across all four domains were reported by patients who had tonsillar cancers, possibly indicative of the limited participation of the tonsil and tonsillar region in the swallow process.

There are some data available in the literature that shows that advanced T stage is associated with poor swallow function and swallowing-related QOL in patients [6, 13–15]. In the present study, advanced tumour size or higher T-stage (T3/T4) were found to be associated with worse mean QOL scores compared to early T-stage (T1/T2) tumours across all four QOL domains. This probably reflects the fact that advanced T-stage disease requires more aggressive/extended surgical resections which, in turn, have greater functional implications for the swallow. Also, multiple surgical procedures, such as neck dissection and reconstruction, are usually required by these patients that may further compromise swallow function and reduce the QOL in these patients.

There is no consensus in the literature if reconstruction of the surgical defect results in better swallowing outcome and swallowing-related QOL [13, 17, 18]. However, in this study we found that the patients who underwent reconstruction following tumour resection reported significantly worse mean QOL scores across all four domains of the MDADI compared to those who did not require reconstruction. This observation may simply be a reflection of the extent of the surgical defect but it should be borne in mind that flaps are often bulky and akinetic and may hinder the mobility of residual normal structures within the oral cavity and the oropharynx, hence directly affecting oral and the pharyngeal phases of swallowing. There is a general agreement among clinicians that to obtain the best possible level of functional outcomes and a good QOL, the reconstruction should aim to maintain as much mobility as possible of the structures in the oral cavity and the oropharynx [6, 19, 20].

The age of the patient at the time of diagnosis may also impact swallowing function and swallowing-related QOL. It is generally expected that older patients will report worse swallowing function and QOL secondary to age-related abnormal motility of the upper digestive tract due to age-related loss of enteric neurons [21]. However, in this study the mean QOL scores were significantly worse for younger patients across physical and emotional domains (Table 2). The reason for these counterintuitive results may be a difference in the level of expectations of functional out-

comes and QOL between younger and older patients. Younger patients may have higher expectations than their older counterparts, which at times may be difficult to achieve even with optimal treatment strategies and rehabilitation protocols [22, 23].

The effect of gender on swallow function and swallowing-related QOL in OC and OP cancer patients is unclear as some studies report worse QOL [6] or no difference [22] in the QOL in females while other studies report better outcomes in females as compared to males [24, 25]. In the present study, the mean QOL scores were slightly better for male patients as compared to females across all the four QOL domains, however, the results were not significant. These variations in the mean QOL scores may be secondary to differences in coping mechanisms between male and female patients, albeit the effects are minimal in the long term.

To date, there are no comprehensive direct studies that compare the effect of surgical and non-surgical treatment modalities on swallowing function and swallowing-related QOL in OC and OP cancer patients. Also the opinion is divided as to whether organ-preservation helps in restoring swallowing function in OC and OP cancer patients [2, 26]. However, there appears to be a consensus that the addition of radiotherapy or chemo-radiotherapy following surgery confers additional morbidity [13, 24, 27]. In the present study, consistently worse mean QOL scores were noted in all the four domains for patients who received post-operative radiation therapy (PORT) or post-operative chemo-radiotherapy (POCRT) compared to patients who were treated by surgery alone. These differences may be due to secondary changes associated with PORT or POCRT, such as xerostomia, thick saliva, trismus, soft tissue necrosis, sensory changes and generalized fibrosis in the irradiated field, that may affect neuromuscular coordination and the mobility of the structures such as tongue base, hyoid bone and the larynx [6, 13], which are not seen in patients treated with surgery alone.

The current literature regarding the impact of length of follow-up on swallowing function and swallowing-related QOL in OC and OP cancer patients is also unclear. Some studies report better swallowing function and QOL in these patients over time [24, 28], while others report the opposite [6]. In the present study, we found that the mean QOL scores were consistently worse across all four domains for patients who had completed treatment more than 2 years previously, however, these findings were not significant. The addition of chemotherapy and radiotherapy has also been associated with higher rates of long-term swallowing problems [29]. Several patients in the study may not have recovered fully from the side effects of the treatment at the time of questionnaire and thus may have reported lower QOL scores.

The limitations of this study were its cross-sectional nature and the retrospective review of medical records which may be inconsistent. In addition, the sample number may be relatively small for some sub-group comparisons. As this study was conducted at a tertiary cancer care centre, there may be some selection bias; we tried to overcome this by recruiting consecutive patients.

Conclusion

MDADI is a useful tool for evaluation of different aspects of swallow-related QOL of HNC patients. Younger patients with advanced T-stage cancers of the tongue (base or oral tongue) that require reconstructive surgery perceive worse swallowing function and poor QOL. The impact of gender and length of follow-up warrants further investigation. There is a need for prospective randomized controlled trials to investigate the impact of surgical versus non-surgical treatment on swallow function and swallowing-related QOL in OC and OP cancer patients.

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

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Conflict of interest None to declare.

References

- Dwivedi RC, St Rose S, Roe JW, Khan AS, Pepper C, Nutting CM, Clarke PM, Kerawala CJ, Rhys-Evans PH, Harrington KJ, Kazi R (2010) Validation of the Sydney Swallow Questionnaire (SSQ) in a cohort of head and neck cancer patients. *Oral Oncol* 46(4):e10–e14
- Gillespie MB, Brodsky MB, Day TA, Lee FS, Martin-Harris B (2004) Swallowing-related quality of life after head and neck cancer treatment. *Laryngoscope* 114(8):1362–1367
- Manikantan K, Rhode S, Dwivedi RC, Palav R, Nutting CM, Rhys-Evans P, Harrington KJ, Kazi R (2009) Making sense of post-treatment surveillance in head and neck cancer: when and what of follow-up. *Cancer Treat Rev* 35(8):744–753
- Kazi R, Prasad V, Venkitaraman R, Nutting CM, Clarke P, Rhys-Evans P, Harrington KJ (2008) Questionnaire analysis of swallowing-related outcomes following glossectomy. *ORL J Otorhinolaryngol Relat Spec* 70(3):151–155
- Sayed SI, Elmiyeh B, Rhys-Evans P, Syrigos KN, Nutting CM, Harrington KJ, Kazi R (2009) Quality of life and outcomes research in head and neck cancer: a review of the state of the discipline and likely future directions. *Cancer Treat Rev* 35(5):397–402
- Suarez-Cunquero MM, Schramm A, Schoen R, Seoane-Lestón J, Otero-Cepeda XL, Bormann KH, Kokemueller H, Metzger M, Diz-Dios P, Gellrich NC (2008) Speech and swallowing impairment after treatment for oral and oropharyngeal cancer. *Arch Otolaryngol Head Neck Surg* 134(12):1299–1304
- Pauloski BR, Rademaker AW, Logemann JA, Newman L, MacCracken E, Gaziano J, Stachowiak L (2006) Relationship between swallow motility disorders on videofluorography and oral intake in patients treated for head and neck cancer with radiotherapy with or without chemotherapy. *Head Neck* 28(12):1069–1076
- Gillespie MB, Brodsky MB, Day TA, Sharma AK, Lee FS, Martin-Harris B (2005) Laryngeal penetration and aspiration during swallowing after the treatment of advanced oropharyngeal cancer. *Arch Otolaryngol Head Neck Surg* 131(7):615–619
- Borggreven PA, Verdonck-de Leeuw IM, Muller MJ, Heiligers ML, de Bree R, Aaronson NK, Leemans CR (2007) Quality of life and functional status in patients with cancer of the oral cavity and oropharynx: pretreatment values of a prospective study. *Eur Arch Otorhinolaryngol* 264(6):651–657
- Chen AY, Frankowski R, Bishop-Leone J, Hebert T, Leyk S, Lewin J, Goepfert H (2001) The development and validation of a dysphagia-specific quality-of-life questionnaire for patients with head and neck cancer: the M. D. Anderson dysphagia inventory. *Arch Otolaryngol Head Neck Surg* 127(7):870–876
- List MA, Ritter-Sterr C, Lansky SB (1990) A performance status scale for head and neck cancer patients. *Cancer* 66(3):564–569
- McHorney CA, Robbins J, Lomax K, Rosenbek JC, Chignell K, Kramer AE, Bricker DE (2002) The SWAL-QOL and SWAL-CARE outcomes tool for oropharyngeal dysphagia in adults: III. Documentation of reliability and validity. *Dysphagia* 17(2):97–114
- Zuydam AC, Lowe D, Brown JS, Vaughan ED, Rogers SN (2005) Predictors of speech and swallowing function following primary surgery for oral and oropharyngeal cancer. *Clin Otolaryngol* 30(5):428–437
- Infante-Cossio P, Torres-Carranza E, Cayuela A, Hens-Aumente E, Pastor-Gaitan P, Gutierrez-Perez JL (2009) Impact of treatment on quality of life for oral and oropharyngeal carcinoma. *Int J Oral Maxillofac Surg* 38(10):1052–1058
- Nguyen NP, Vos P, Moltz CC, Frank C, Millar C, Smith HJ, Dutta S, Alfieri A, Lee H, Martinez T, Karlsson U, Nguyen LM, Sallah S (2008) Analysis of the factors influencing dysphagia severity upon diagnosis of head and neck cancer. *Br J Radiol* 81(969):706–710
- McConnel FM (1988) Analysis of pressure generation and bolus transit during pharyngeal swallowing. *Laryngoscope* 98(1):71–78
- Markkanen-Leppänen M, Isotalo E, Mäkitie AA, Rorarius E, Asko-Seljavaara S, Pessi T, Suominen E, Haapanen ML (2006) Swallowing after free-flap reconstruction in patients with oral and pharyngeal cancer. *Oral Oncol* 42(5):501–509
- McConnel FM, Pauloski BR, Logemann JA, Rademaker AW, Colangelo L, Shedd D, Carroll W, Carroll W, Lewin J, Johnson J (1998) Functional results of primary closure vs flaps in oropharyngeal reconstruction: a prospective study of speech and swallowing. *Arch Otolaryngol Head Neck Surg* 24(6):625–630
- Borggreven PA, Verdonck-de Leeuw I, Langendijk JA, Doornaert P, Koster MN, de Bree R, Leemans CR (2005) Speech outcome after surgical treatment for oral and oropharyngeal cancer: a longitudinal assessment of patients reconstructed by a microvascular flap. *Head Neck* 27(9):785–793
- Nicoletti G, Soutar DS, Jackson MS, Wrench AA, Robertson G (2004) Chewing and swallowing after surgical treatment for oral cancer: functional evaluation in 196 selected cases. *Plast Reconstr Surg* 114(2):329–338

21. Meciano Filho J, Carvalho VC, de Souza RR (1995) Nerve cell loss in the myenteric plexus of the human esophagus in relation to age: a preliminary investigation. *Gerontology* 41:18–21
22. Langius A, Björvell H, Lind MG (1994) Functional status and coping in patients with oral and pharyngeal cancer before and after surgery. *Head Neck* 16(6):559–568
23. Chandu A, Sun KC, DeSilva RN, Smith AC (2005) The assessment of quality of life in patients who have undergone surgery for oral cancer: a preliminary report. *J Oral Maxillofac Surg* 63(11):1606–1612
24. Schliephake H, Jamil MU (2002) Prospective evaluation of quality of life after oncologic surgery for oral cancer. *Int J Oral Maxillofac Surg* 31(4):427–433
25. Rogers SN, Lowe D, Brown JS, Vaughan ED (1998) A comparison between the University of Washington Head and Neck Disease-Specific measure and the Medical Short Form 36, EORTC QOQ-C33 and EORTC Head and Neck 35. *Oral Oncol* 34(5):361–372
26. Denittis AS, Machtay M, Rosenthal DI, Sanfilippo NJ, Lee JH, Goldfeder S, Chalian AA, Weinstein GS, Weber RS (2001) Advanced oropharyngeal carcinoma treated with surgery and radiotherapy: oncologic outcome and functional assessment. *Am J Otolaryngol* 22(5):329–335
27. Shiley SG, Hargunani CA, Skoner JM, Holland JM, Wax MK (2006) Swallowing function after chemoradiation for advanced stage oropharyngeal cancer. *Otolaryngol Head Neck Surg* 134(3):455–459
28. Klug C, Neuburg J, Glaser C, Schwarz B, Kermer C, Millesi W (2002) Quality of life 2–10 years after combined treatment for advanced oral and oropharyngeal cancer. *Int J Oral Maxillofac Surg* 31(6):664–669
29. Adelstein DJ, Saxton JP, Lavertu P, Tuason L, Wood BG, Wana-maker JR, Eliachar I, Strome M, Van Kirk MA (1997) A phase III randomized trial comparing concurrent chemotherapy and radiotherapy with radiotherapy alone in resectable stage III and IV squamous cell head and neck cancer: preliminary results. *Head Neck* 19(7):567–575