Feasibility of tongue strength measurements during (chemo)radiotherapy in head and neck cancer patients

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Abstract

Purpose

The aim of this study was to investigate the feasibility of tongue strength measures (TSMs) and whether there is a relationship with bulb location, gender, and self-perceived pain and mucositis scores in head and neck cancer (HNC) patients during concurrent chemoradiotherapy (CRT).

Methods

Twenty-six newly diagnosed HNC patients treated with CRT performed anterior and posterior maximal isometric tongue pressures by means of the Iowa Oral Performance Instrument (IOPI). The Oral Mucositis Weekly Questionnaire (OMWQ) and a Visual Analogue Scale (VAS) for pain during swallowing were completed weekly from baseline to 1 week post CRT.

Results

Feasibility of TSMs during CRT declines significantly from 96-100% at baseline to 46% after 6 weeks of CRT. No effect of gender or bulb location was established, but feasibility was influenced by pain and mucositis.

Conclusions

Feasibility of TSMs declines during CRT and is influenced by mucositis and pain. For the majority of subjects TSMs were feasible within the first 4 weeks, which provides a window of scientific and clinical opportunities in this patient population.

Keywords

Head and Neck Cancer, Dysphagia, Deglutition, Tongue Strength, Chemoradiotherapy

Met opmerkingen [DVG1]: Measurements?

Met opmerkingen [DVG2]: Verder gebruik je steeds CRT …

Met opmerkingen [DVG3]: Waarom verander je de volgorde?

Met opmerkingen [DVG4]: Of: but pain and mucositis influenced/did influence feasability

Met opmerkingen [DVG5]: Waarom verander je de volgorde?

Introduction

Head and neck cancer (HNC) is one of the most distressing cancers, with a major impact on quality of life (QoL) [1]. The improvement of tumour response, loco-regional control and survival by adding chemotherapy concurrently to radiotherapy (i.e. chemoradiotherapy (CRT)) since the nineties, is reflected in an organ sparing but unfortunately not in a function-sparing outcome [2-4]. Sequelae of CRT such as pain, oedema, xerostomia, and ongoing fibrosis negatively impact mouth opening, chewing, speech, and swallowing [5].
Dysphagia is a common, and one of the most serious and disabling complications associated with CRT in HNC patients, yet underreported [6]. CRT-associated collateral damage to healthy tissues involved in the oropharyngeal swallow is often inevitable. The acute radiation effects and ever-continuing radiation-induced fibrosis ultimately results in muscular disuse or atrophy, contributing to the decline in swallowing function [4,6,7]. This results primarily in difficulties with adequate and safe transportation of food and/or liquids from the mouth to the pharynx and subsequently into the esophagus, which can lead to residue and aspiration [8]. Secondary complications of dysphagia can include prolonged meal duration, malnutrition, feeding tube dependency, hospitalization for treatment of pain or weight loss, aspiration pneumonia, and increased mortality [6,9]. All these aspects can directly or indirectly negatively impact a person's QoL [10,11,12].
Acute dysphagia (defined as problems during ongoing CRT or shortly afterwards) has often been considered of lesser importance by clinicians due to its transient nature. However, a pioneering study from King et al. demonstrates muscle deterioration even shortly after completion of CRT caused by reduced strength, atrophy, and fatty infiltration [13]. Due to this insight and the notion that radiotherapy (RT)-induced fibrosis syndrome is a never-ending, progressive process, the importance of prophylactic exercises is increasingly acknowledged. Data indicating that prophylactic swallowing therapy may prevent or limit long-term swallowing CRT-induced swallowing disorders are accumulating [12,14-19]. However, due to a lack of sufficient knowledge on functional and physiological changes during CRT, a consensus on therapy content is still missing [20].

One important underlying mechanism of dysphagia in HNC patients following CRT is reduced tongue strength (TS), the main driving force for food propulsion, due to the described muscular disuse and/or muscle atrophy [21,22]. TS is the main driving force for food propulsion [9]. Besides bolus propulsion, insufficient TS is associated with aspiration and endangers adequate oral nutrition [23-25]. This pivotal role of TS merits a more profound knowledge, and forms the basis of our research question.

Measuring tongue strength in HNC patients during and following their treatment will raise the knowledge and insight in the described process of muscle deterioration. In the long run, profound knowledge on the evolution of tongue strength is necessary to develop therapeutic interventions to prevent and rehabilitate oropharyngeal dysphagia. Although measuring TS during CRT has both a clinical and scientific value, the feasibility of these measures has not yet been documented.

To measure TS intra-oral electrodes, fixed to a hard shield plate or an air-filled balloon such as the Iowa Oral Performance Instrument (IOPI [26],) are used to register the tongue-palate pressures generated by the patient. This implies surface contact between mucosa of the tongue and hard palate and the electrode or plastic bulb, respectively. Extensive normative data collection in healthy adults has verified the feasibility of measuring TS by the IOPI [27-30]. However, CRT-treated HNC patients must deal with oral mucositis as an acute side effect, which can cause pain and soreness in the mouth and throat [31,32]. Therefore TSMs by means of a device during CRT are controversial.

The main aim of this study was to investigate the feasibility of TSMs in CRT-treated HNC patients at baseline, weekly during CRT and one week after completion of the treatment. Secondary aims were examining the influence of anterior or posterior bulb location, gender, and self-perceived effects of pain and mucositis on feasibility.

Met opmerkingen [DVG6]: Meta-analyse van Pignon

Met opmerkingen [DVG7]: Add: Langendijk 2008!

Met opmerkingen [DVG8]: Kan je ook in de voorgaande zin verwerken, al riskeert die dan wel wat lang te worden

Met opmerkingen [DVG9]: Of?

Met opmerkingen [DVG10]: Measurements?

Methods

Participants

This paper presents swallowing data of 26 subjects, collected between August 2012 and April 2015 at the Antwerp University Hospital in the context of the Cancer Plan Project KPC29_033 . During this period, all patients with a new diagnosis of a primary squamous cell carcinoma of the oral cavity, oropharynx, hypopharynx, and/or larynx, meeting the inclusion/exclusion criteria were invited to participate in the Cancer Plan study. Inclusion criteria were the presence of sufficient cognitive and language abilities. A history of prior carcinoma and/or cancer surgery or CRT in the head and neck region and presence of metastasis were essential exclusion criteria. Table 1 provides detailed information on age, gender, tumor size, and treatment of each subject.

Table 1: characteristics of subjects (*N*=26)

Age	Gender	Tumor (T) size	Treatment	Tumor location
53	male	T3	CCRT	oropharynx
62	male	T2	CCRT	oropharynx
79	male	T2	CCRT	oropharynx
69	female	T1	CCRT	oropharynx
55	female	T3	CCRT	oropharynx
59	female	T1	RT	oropharynx
52	male	T2	CCRT	oropharynx
63	male	T3	CCRT	oral cavity, oropharynx, hypopharynx
77[1]	male	T3	CCRT	hypopharynx
76[2]	female	T2	RT	oropharynx
75	female	T4a	SCRT	oropharynx
62	male	T4a	SCRT	oropharynx
51	male	T1	CCRT	oropharynx
63	male	T2	CCRT	hypopharynx
46	male	T2	CCRT	larynx
65	male	T3	CCRT	oropharynx
64	male	T3	CCRT	hypopharynx, larynx
73	male	T4a	CCRT	oropharynx
50	male	T1	CCRT	oropharynx
53	female	TX	CCRT	oropharynx en hypopharynx
71	female	T4a	CCRT	larynx
63	female	T2	CCRT	oropharynx
78[3]	male	T4a	CCRT	hypopharynx
70	male	T2	CCRT	larynx
63	male	T4a	SCCRT	oropharynx
57	male	Tu	CCRT	oropharynx en hypopharynx

CRT: concurrent chemoradiotherapy; RT: radiotherapy; SCRT: sequential chemoradiotherapy
drop-out during follow-up: 1-death, 2-occurrence of metastasis, 3-rejection by the subject

Material and procedure

The Iowa Oral Performance Instrument (IOPI [26]) with an air-filled bulb was used to perform TSMs, similarly to a procedure previously described [32]. For anterior TSMs the distal end of the air filled balloon was placed right behind the upper incisors, for posterior TSMs the tip of the balloon was positioned at the transition between the soft and hard palate. Participants were instructed to generate maximal isometric tongue-palate pressures (MIP), pushing the tongue as hard as possible against the tongue bulb for 3 seconds. These motivated trials using verbal encouragement were repeated 3 times anteriorly and 3 times posteriorly with 10-second breaks between consecutive measurements. The examiner visually assessed correct strip placement between each trial.

Data collection

TSMs were performed prior to CRT (baseline, BL), after 1, 2, 3, 4, 5, and 6 weeks of CRT (CRT1, CRT2, CRT3, CRT4, CRT5, CRT6), and 1 week post CRT (post CRT). Feasibility was expressed as the percentage of participants able to perform 3 consecutive anterior or posterior TSMs. TSMs were only labeled as feasible if the subject felt unrestricted and able to produce maximal tongue-palate pressures.

The Oral Mucositis Weekly Questionnaire-Head and Neck Cancer or OMWQ-HN [34] was used to investigate self-perceived effects of mucositis. The OMWQ-HN is a validated patient reported outcome (PROM) questionnaire that measures the symptoms of mucositis, including mouth and throat soreness, as well as their impact on patient's well-being and function. It consists of 6 questions with a maximum score of 61; the higher the score, the higher the impact of mucositis on well-being and function. Subjects also completed a 100 mm visual analogue scale (VAS) - ranging from 'no pain at all at swallowing' (0) to 'swallowing is extremely painful' (100).

Data analysis

Statistical analysis was performed using SPSSv21. Descriptive analyses were used to calculate the overall feasibility and the feasibility at each investigated point in time. The effect of time on feasibility of TSMs was

Met opmerkingen [DVG11]: Nu ineens CCRT gebruiken is natuurlijk wat verwarrend…
Wat hield de SCRT in? Is dit inductie dan zet je beter ICT; is dit inductie gevolgd door CRT dan zet je beter ICT→CRT; is dit alternerend chemo en RT dan zet je beter bvb RT→CT→RT
Dit is ook algemeen duidelijker naar het optreden van je neveneffecten toe. Bovendien heb je plaats genoeg om het zo uit te schrijven

Met opmerkingen [DVG12]: Heeft deze pat 3 synchrone tumoren of gewoon 1 uitgebreide tumor?

Met opmerkingen [DVG13]: Wat bedoel je hier mee?

Met opmerkingen [DVG14]: This is not clear, better put IOPI

Met opmerkingen [DVG15]: Voluit schrijven?

investigated by Cochrane's Q test, supplemented with McNemar tests with Holm-Bonferoni correction as post-hoc analysis [35]. The effects of gender and bulb location were determined by chi-square (χ^2) analyses. The effect of pain during swallowing and self-perceived mucositis was investigated by comparing global results on VAS and OMWQ between the group of feasible TSMs (group 1) and the group of unfeasible TSMs (group 2).

Ethical committee

This study was approved by the Ethical Committee of the Antwerp University Hospital (B300201318333). All subjects agreed voluntarily to participate in this study and signed an informed consent.

Results

Feasibility of tongue strength measures

We used an alpha level of .05 for all statistical tests. Figure 1 illustrates the evolution of TSMs feasibility during CRT. This evolution is highly significant ($p < .001$) with an almost linear decline of feasibility during CRT. Figure 1 shows TSMs to be feasible in the majority of participants until CRT5, followed by a drop in feasibility. Post-hoc analyses showed statistically significant differences in feasibility of anterior TSMs between baseline and CRT4 ($p = .040$), CRT5 ($p = .024$), CRT6 ($p = .000$), and post CRT ($p = .048$). For posterior TSMs, statistically significant differences mimicked between baseline and CRT4 ($p = .016$), CRT5 ($p = .010$), CRT6 ($p = .000$), and post CRT ($p = .006$), with an additional significant difference between BL and CRT1 ($p = .048$). There were no other significant effects between baseline and other moments, nor between 2 consecutive moments in time. The effect of bulb location was not significant ($\chi^2 = 0{,}001$; $p = .980$).

Met opmerkingen [DVG16]: Meaning?

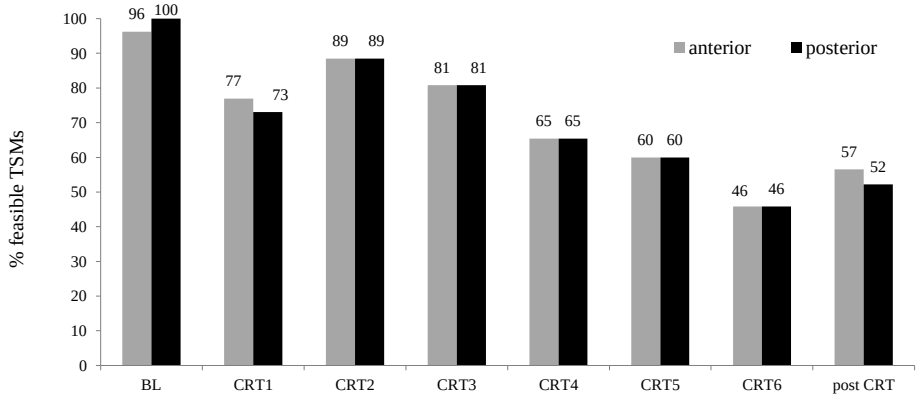

Figure 1: evolution of feasibility of anterior and posterior tongue strength measures (TSMs) during CRT

Effect of gender on feasibility

No gender effect was found for either anterior nor for posterior TSMs ($\chi^2 = 0{,}715$; $p = .398$ and $\chi^2 = 0{,}893$; $p = .345$).

Effect of mucositis related symptoms on feasibility

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Figures 2 and 3 respectively illustrate the distribution of the OMWQ and VAS values of group 1 (feasible TSMs) and group 2 (unfeasible TSMs). The difference between both groups is highly significant for the OMWQ score ($t(128) = 3.154$, $p = .002$ for ANT TSMs and $t(128) = 3.570$, $p = .001$ for POST TSMs), as well as for the pain during swallowing ($t(153) = 3.497$, $p = .001$ for ANT TSMs and $t(153) = 3.611$, $p < .001$ for POST TSMs). The scores of group 2 are higher for both variables, indicating a higher self-perceived presence and impact of mucositis. Nonetheless, Figures 4 and 5 show a substantial overlap between the values of both groups.

Met opmerkingen [DVG17]: Dit zie ik niet in de figuur

Met opmerkingen [DVG18]: Deze vind ik niet terug

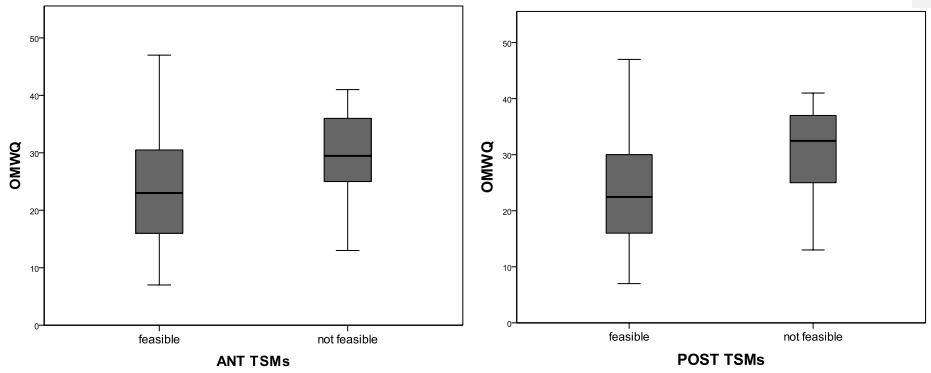

Figure 2: Oral Mucositis Weekly Questionnaire-scores (OMWQ) for anterior (ANT) and posterior (POST) tongue strength measures (TSMs)

Met opmerkingen [DVG19]: 4?

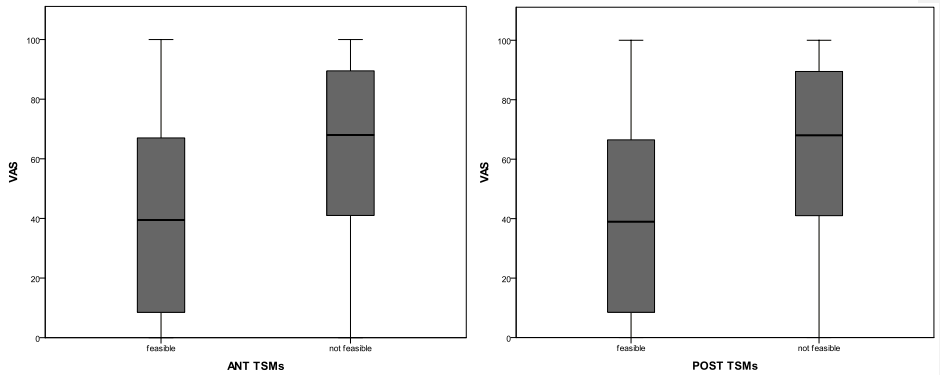

Figure 3: pain on a Visual Aanalogue Scale (VAS) for anterior (ANT) and posterior (POST) tongue strength measures (TSMs)

Met opmerkingen [DVG20]: 5?

Discussion

As discussed in the introduction, TSMs during CRT have a high clinical and scientific relevance. Since TSMs and/or TSE involve direct contact between the oral mucosa and the measuring/therapy device, the feasibility of these activities has been questioned.
The results of this study show a significant decline in feasibility from 96-100% anteriorly and posteriorly, respectively, at baseline to 46% for both locations after 6 weeks of CRT. Post-hoc analyses reveal significant decrease in feasibility from 4 weeks of treatment on. No significant effect of gender or bulb location was found, but feasibility is clearly influenced by (self-perceived) mucositis and pain. The latter stresses the presumable importance of pain management in this population [20,27]. Adequate pain management is not only necessary for preservation of swallowing function and eating during CRT [37], it also creates opportunities for prophylactic swallowing interventions.
However, the substantial overlap in scores for mucositis and pain between the feasible and non-feasible group also shows that pain and mucositis cannot be considered as solid nor as the only predictors for feasibility. This implies that self-reporting pain from patients is insufficient to guide clinicians whether to continue TSE or not. There are likely other patient- and therapist-related factors, such as intrinsic motivation, which can influence the feasibility and possible success of a therapy program. This might be an interesting topic for future research. Future perspectives could also focus on the effect of intrinsic motivation of the subjects as a possible predictor of feasibility in addition to pain and mucositis.

Our study is the first to demonstrate the feasibility of TSMs with a device which implicates surface contact with the – often painful – tissue of the tongue and palate during CRT.
The main limitation of this pilot study is the relative small number of subjects and the monocentric design. The limited sample size is largely explained by the strict inclusion/exclusion criteria, as well as lack of patients' motivation.

In summary, the high feasibility during the first four-five weeks of treatment creates opportunities to collect data about evolution of TS during (chemo)radiotherapy. In addition, it provides support for the use of prophylactic tongue strengthening exercise regimens during CRT. This opens a window of opportunities to expand our knowledge on the acute physiological impact of CRT, as well as the feasibility of TSE in a prophylactic swallowing setting.

Met opmerkingen [DVG21]: Je moet ook wel de drop tussen de BL en de eerste week bediscussiëren: motivatie? Angst? Chemo? ....
En ook waarom het 1 week na de RT al weer beter gaat alhoewel we op dat moment klinisch slecht zelden een verbetering zien

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