Dysphagia following radical chemoradiotherapy treatment for HNSCC

Abstract
Chemoradiotherapy is an organ sparing treatment for advanced head and neck cancer. However, it can have short and long-term effects on basic functions such as swallowing. Eating and drinking is an important issue for patients and their quality of life. Early post-treatment effects include mucositis, oedema, xerostomia and taste changes, making swallowing painful and secretion management difficult. Long-term effects include fibrosis and persistent oedema, which compromises swallowing ability with patients at risk of aspiration, dependency on feeding tubes and nutritional deficiency. Depending on its severity, dysphagia can lead to serious medical problems such as pneumonia. This article aims to review swallowing assessment procedures, common features of a post-chemoradiotherapy swallowing impairment and rehabilitation.

Key words
Dysphagia, Chemoradiotherapy, Head and neck cancer

Background
Chemoradiotherapy (CRT) for advanced head and neck cancer has been labelled an ‘organ preservation’ treatment as the surgical removal of organs is avoided. However, patients can experience a number of symptoms and functional impairments months and even years following their treatment, dysphagia being the most common long-term side effect. The National Veterans Affairs Larynx Cancer Trial was a landmark study, comparing CRT with the traditional treatment method of surgery and radiotherapy for laryngeal cancer. The second part of this trial reported on the functional consequences of both these treatments. Up to a third of patients said they had long-term swallowing difficulties, regardless of the treatment modality. The authors were ‘surprised’, assuming the organ preservation group, i.e. CRT, would report fewer problems with function and were unable to offer an explanation for this finding. Since this study, CRT clinical trials for HNC have focused on survival rates, suggesting at least equitable outcomes compared with historical surgical controls. There is little literature that directly compares the two approaches. Unfortunately, clinical trials have not included swallowing ability as an outcome measure.

Normal swallowing
Swallowing is an integrated and finely tuned process which allows the free passage of solids or liquids from the lips, through the mouth and throat, towards the stomach via the oesophagus. It is complex, primarily because the oropharynx is a shared channel for swallowing and respiration. It involves the co-ordination of over 25 pairs of muscles, under both voluntary and involuntary neural control. Swallowing needs to be executed safely, to avoid the spillage of material into the airway and beyond. It has to be performed efficiently, to ensure adequate nourishment and hydration is maintained.

Changes in swallowing occur as part of the natural ageing process, resulting in longer swallowing transit times and reduced food bolus propulsion. Transit times are also marginally slower in females compared to males.

The importance of dysphagia
Eating and drinking is a major concern for head and neck cancer patients. In our cohort of CRT patients, swallowing was the most commonly selected important issue across all time points (Figure 1). It may also lead to serious medical complications such as pneumonia and significant weight loss.

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Relationship with quality of life (QOL)

Dysphagia is strongly associated with a poorer QOL [3]. Videofluoroscopy findings have been compared with QOL questionnaires. Patients presenting with none-mild swallowing impairment had significantly better QOL than those with more severe impairment. Furthermore, the presence of a feeding tube and swallowing difficulties are strong predictors of a reduced quality of life. Feeding tubes may also disrupt lifestyle for additional reasons such as a continuing need for personal care and restrictions in activity or work.

Aspiration

Swallowing safety relates to aspiration i.e. entry of food or liquid into the airway below the true vocal folds (Figure 2).

Aspiration can be due to incompetent or inadequate airway protection, ill-timed, uncoordinated events before, during or after the swallow has triggered. HNC patients may lack sufficient laryngeal sensation to detect aspiration and therefore no attempt is made to expectorate any inhaled material. This is termed sub-clinical or ‘silent’ aspiration and can be easily missed by both clinician and patient due to the lack of overt symptoms. Patients who aspirate are at increased risk of respiratory problems such as airway obstruction or aspiration pneumonia. One study reported a 9% mortality rate in HNC patients who were known to aspirate. Elsewhere, only a quarter of patients had a history of pneumonia despite over 50% presenting with aspiration. Up to a third of patients fed by tube and on minimal oral intake developed aspiration pneumonia. Additional factors may be needed to be present for pneumonia to develop e.g. dependency on someone else for feeding, poor oral hygiene and immobility. This population may have other mitigating factors, such as neutropenia i.e. abnormal decrease in white blood cells or malnutrition. Prolonged, repeated aspiration of small amounts of material and chronic chest infections has been associated with the development of interstitial pulmonary fibrosis. Head and neck cancer patients may be susceptible to this, given that swallowing can deteriorate in the long-term. Anecdotally, it is not uncommon for HNC patients to be re-referred to speech & language therapy services with persistent chest problems secondary to aspiration, several years after their initial treatment.

Malnutrition & dehydration

Malnutrition is well-recognised as a poor prognostic indicator for HNC patients. Up to 59% of HNC patients are classified as malnourished at diagnosis and mean weight loss during CRT is reported to be 9-12% of the initial body weight. Adequate nutrition and hydration are major clinical concerns.

Figure 1: Patients’ priorities pre- and post-CRT measured on the University of Washington Quality of Life Scales at four time points.

Figure 2: Aspiration of liquid bolus on a fibreoptic endoscopic evaluation of swallowing.
in patients with dysphagia. The degree to which abnormal swallowing function precludes oral intake may be variable, with some patients continuing to eat and drink despite significant swallow pathophysiology.11

How to measure dysphagia

Clinical swallow evaluation

In practice, a clinical swallowing evaluation (CSE) is the first step in dysphagia assessment. A CSE incorporates a measure of function and identification of any risks i.e. aspiration or significantly reduced efficiency. In addition, consideration may be given to whether an instrumental assessment is necessary and a treatment plan drawn up. It usually involves gathering information on

- patient demographics
- medical issues relating to dysphagia e.g. respiratory status
- disease characteristics e.g. tumour site
- proposed surgical/oncological treatment plan

An oromotor and physical examination and a swallow test are performed to observe for any signs of dysfunction. We have shown that a timed water swallow test (100mL WST) can be easily integrated into a CSE. The patient is asked to drink 100mLs of water as quickly as they can comfortably manage and the time taken is recorded. Pre-treatment HNC patients have significantly poorer WSTs, than a group of healthy volunteers.12 Furthermore, those with pharyngeal tumours and/or advanced disease had poorer scores than other tumour sites and early staged cancer. In addition, our work has demonstrated that the 100mL WST test has excellent sensitivity (80%) and specificity (77%) for identifying aspiration,11 and therefore can be used for selecting patients who may require an instrumental assessment. Clinically, this test can be used to monitor for any changes over time and is useful to quantify outcomes of interventions such as serial dilatation.

Instrumental assessment

An instrumental assessment is recommended when not all clinical questions have been answered by a CSE. This type of assessment aims to (1) record the swallow (patho)physiology (2) establish whether the patient is aspirating or is at risk of aspiration (3) determine the efficiency of the swallow as a predictor of maintenance of adequate nutrition and hydration and (4) identify those strategies or interventions which may remediate the dysfunction. A videofluoroscopy swallow study (VFSS) is the most commonly reported instrumental assessment reported in the HNC literature. It is conducted using food and liquid boluses (of varying volumes) mixed with radio-opaque contrast, tracking the swallowing process from the oral cavity to the upper oesophagus (Figure 3). A standardised protocol for performing a VFSS for HNCSCC clinical trials has been outlined by an international consensus panel.14

Fibreoptic Endoscopic Evaluation of Swallowing (FEES) is also commonly used and allows direct visualisation of both the pharynx and larynx, and their non-degluttive function. The endoscopic view allows an assessment of secretion management and can include laryngopharyngeal sensory testing. The test can easily be performed in an out-patient setting (Figure 4).

Although VFSS and FEES provide complementary information, either test may be used for assessing laryngeal penetration, aspiration, pharyngeal residue and the response to therapeutic interventions such as postural changes. Recent evidence has demonstrated good reliability for interpreting both of these assessments.15-17

Type of Diet

Dysphagia in HNC patients has been shown to restrict food textures which can compromise oral intake and patient satisfaction.5 The Performance Status Scales (PSS) are the most commonly reported measurement of diet textures in the HNC literature (Box 1) and are included as an outcome measure in the national Dataset for Head and Neck Oncology (DAHNO). The PSS were intended for both research and clinical purposes and consist of a brief three item assessment recording aspects of eating and drinking function. The Normalcy of diet sub-section of the PSS is the only validated scale of food textures specifically designed for use with HNC patients. It has a strong association with patient reported swallowing questionnaires and clinical measures of swallowing impairment.
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### Characteristics of post chemoradiotherapy dysphagia

#### The clinicians’ perspective

In the acute phase of CRT, oral mucositis can be severe and painful with the majority of patients experiencing marked difficulties with eating and drinking. Mucosal adhesions at the post-cricoid level can completely obliterate the upper oesophageal lumen. Xerostomia not only compromises swallowing, but may become fibrotic, atrophic and remain oedematous, signifying chronicity. In the long-term, tissues may become fibrotic, atrophic and remain oedematous, significantly affecting the movement and co-ordination of swallowing. Common problems contributing to swallowing safety, severity and inefficiency are:

- Reduced pharyngeal contractile peristalsis
- Abnormal upper oesophageal opening or partial/total stricture
- Reduced posterior base of tongue retraction

#### The patients’ perspective

Patients’ report a steep drop in their swallowing function from pre- to post-CRT.15 Beyond three months, there appears to be little improvement as measured by questionnaire. This suggests that patients do not experience a ‘response shift’ i.e. changes to the perception of their swallowing or adaptation to their dysphagia over time. Elsewhere, an improvement was noted in patients with nasopharyngeal cancer.22 However, the sample was cross-sectional and patients’ treatment had taken place at least 3 years previously. It is possible therefore that adjustment to dysphagia occurs over a much longer time than 12 months. Our qualitative study confirmed long-term changes to eating and drinking, without a return to pre-morbid functioning.15 Symptoms were more severe and took longer to improve than anticipated. Worries over side effects were more apparent early post-CRT, being replaced by concerns over changes to lifestyle in the long-term.

#### Factors impacting on dysphagia

**Pre-treatment dysphagia**

Pre-treatment swallowing function can be predictive of post-treatment dysphagia.15, 23-25 The same biomechanical disorders present at baseline, were also seen following CRT, but were more severe.21 In our cohort, the 100mL WST was a strong predictor of dysphagia at one year, as was the PSS Normalcy of diet score.15 We also identified that pre-treatment MDADI scores accounted for 13% of the variance of MDADI scores at one year, which is important to note.

**Type of treatment**

Type of treatment is an important predictor of post-treatment swallowing outcomes. Patients receiving a higher dose of conventional radiotherapy had worse swallowing measured by VFSS than those having a lower total dose23, 26 and they were...
more likely to require long-term tube feeding. Patients having unilateral radiotherapy to the neck have better swallowing outcomes than bilateral treatment. Preliminary results on IMRT, where surrounding healthy tissues receive less radiation exposure, suggest a reduction in patient reported dysphagia symptoms. A dose-effect relationship has been found between the involvement of specific structures and swallowing outcomes (pharyngeal constrictors, glottis, supraglottis and upper oesophagus). However, one longitudinal IMRT study showed limited improvements to swallowing pathophysiology over time. The addition of chemotherapy to radiotherapy shows mixed results, some studies showing no difference and others finding increased dysphagia severity. In our own study, CRT patients had more dietary restrictions, poorer water swallow tests and were more likely to aspirate than those receiving radical radiotherapy alone. No differences between these groups were found on patients’ self-report. However, it should be noted that the CRT group also had greater treatment volumes, making it difficult to definitely conclude that these differences were due to the addition of drug therapy. Different chemotherapy protocols have shown minimal differences in dysphagic features.

Age
Age is rarely included in the analysis of HNCSCC studies looking at swallowing impairment. Given that the biomechanics of a healthy swallow change with age, it makes sense that this factor needs to be taken into consideration. On quality of life tools, patients over 70 years reported more swallowing problems than their younger counterparts, but appeared to have better emotional functioning. On swallowing specific questionnaires, age was a predictor of outcome, with older HNC patients having better scores. There are several possible reasons for this age effect. Health expectations may lower with age, making it easier to accept changes to function. Secondly, eating and drinking habits of older people may be different to younger adults. Small studies have shown that older people were likely to consume food in their own homes, rarely eating out and already had changed diets for other reasons, such as loss of teeth. The Food Standards Agency suggest a change to British eating habits, with an increase in the consumption of takeaways, fast foods and eating out. Our younger patients, therefore may experience more lifestyle limitations when living with chronic dysphagia.

Prophylactic feeding tube
More recently, it has been suggested that the selection of feeding tube indirectly affects swallowing outcome in CRT patients. Two studies have compared subjective dysphagia ratings in non-randomised patients fitted with either a prophylactic gastrostomy tube or a reactive nasogastric tube (NGT). Both demonstrated that the reactive NGT patient group had fewer problems, with a trend for better swallowing at six months identified in one, and a significant difference in the other. It is also thought that an NGT may act as a pharyngeal stent, as fewer patients fed by NGT develop a cricopharyngeal stenosis. In our own (non-randomised) study, patients in the reactive NGT group had significantly better MDADI scores than those with a prophylactic gastrostomy. The hypothesis for this difference is that patients with a prophylactic G tube are less likely to persevere with oral intake throughout treatment and therefore the swallowing musculature becomes de-conditioned.

Interventions for post chemoradiotherapy dysphagia

Pre-treatment information
Current guidelines recommend a pre-treatment speech and language therapy assessment for those patients expected to have dysphagia as a result of treatment. Therefore, every patient referred for CRT should be referred for a swallowing consultation. This information is collected by DAHNO. As well as collecting baseline information on function, this consultation should include giving information on the anticipated impact of CRT on functioning. Preparing patients for a swallowing impairment may help with the adjustment to lifestyle changes and highlight those at risk of psychosocial problems.

Swallowing exercises
Swallowing exercises have been designed to improve the range of motion and strength of oral and pharyngeal structures, with the aim of challenging muscle fibrosis. They each address specific swallowing pathophysiology. For example the Shaker exercise targets the upwards and forward movement of the hyoid by focusing on the suprahyploid musculature. In turn, this improves upper oesophageal sphincter opening and has been shown to reduce aspiration. It involves a prescribed number of head lifts in a supine position (Figure 5). Oral range of motion exercises have been shown to be of benefit, but research has only been conducted on post-surgical patients.

Figure 5: An example of the Shaker exercise

More recently, some centres have introduced pre-treatment prophylactic swallowing exercises. The theory is that function is maintained by continuing to activate the swallowing musculature during CRT. To date, there is a small evidence base for this intervention, but with methodological limitations. Swallowing exercises appear effective at maintaining suprahyploid muscle bulk, although no differences were observed on swallowing physiology.

Compensatory strategies
Swallowing manoeuvres are designed to improve airway protection, and reduce aspiration. A common example is the ‘supraglottic swallow’, where patients are taught to close the vocal folds prior to the introduction of a bolus, swallow, then immediately cough out to remove any residue. Manoeuvres may also form part of an exercise programme. These techniques reduced or completely resolved aspiration in irradiated patients. Instructions can be complex and difficult for some patients to learn. Progress may be expedited by the use of videofluoroscopy for biofeedback. Swallowing postures such as chin tuck or head turn can facilitate functioning. They aim to alter the pharyngeal dimensions and change the direction of food and liquid flow. Logemann used postures on 32 head and neck cancer patients who were known to aspirate. 81% patients were able to swallow without aspiration following the introduction of a posture.
Different textures may be advisable for a patient exhibiting certain types of dysphagia. For instance, thickening agents may be added to fluids if there is inadequate airway protection when drinking. Patients may be guided towards increasing the viscosity of their food textures, balancing the safety and efficiency of their swallowing ability. Additional moisture may be required e.g. additional sauce for those with significant xerostomia. Spices may be avoided as this may further irritate the mouth and throat. Taste, temperature and visual appearance may also require discussion for full rehabilitation of eating and drinking habits.

**Neuromuscular electrical stimulation**
Pharyngeal neuromuscular electrical stimulation is designed to strengthen the muscles used in swallowing and to improve laryngeal elevation. An electrical current is activated via electrodes placed on the throat, with the aim of producing a contraction of the mylohyoid (elevating the hyoid bone) and the thyrohyoid in the neck (elevating the larynx). The Royal College of Speech and Language Therapists does not support its use due to concerns over lack of efficacy. Research on this intervention for HNSCC patients is limited and inconclusive. A randomised control trial is currently underway in the USA.

**Maintenance of oral in take**
Using the same theory as proposed for prophylactic exercises, encouraging patients to continue oral feeding for as long as possible throughout CRT will maintain a level of swallowing activity. Keeping nil orally to a minimum and encouraging patient’s swallowing mechanism to stay active, may reduce fibrosis and thus stenosis or strictures after CRT. A retrospective study found that patients following this advice had fewer dietary restrictions in the long-term. This treatment plan requires close monitoring, to balance out the risks associated with aspiration. For this reason, regular reviews by a diettitian and speech and language therapist is required during CRT is necessary. Pain needs to be carefully managed as this is a significant problem during treatment.

**Surgical interventions**
Evidence for surgical management of dysphagia following CRT is largely confined to surgical or balloon dilatation or laser myotomy for upper oesophageal strictures, mucosal adhesions or stenosis. The reported incidence of this complication is variable, ranging from 13 to 37%. However, patients were selected on the basis of a reported swallowing difficulty, thus biasing the samples. Strictures/stenosis are likely to co-occur with oropharyngeal dysphagia, and therefore, this intervention alone is unlikely to fully rehabilitate the swallow and patients should be counselled accordingly.

One centre has reported swallowing outcomes for laryngeal suspension post-radiotherapy. In this procedure, the larynx is raised and secured to the mandible, thus placing it in a more protective position, under the base of tongue. It is usually reserved for patients under-going major resections. Results are variable and again, it is likely that difficulties with laryngeal elevation are likely to co-occur with other biomechanical problems, limiting the success of this intervention alone in rehabilitating the swallow.

Laryngectomy may be considered for patients with a severely dysfunctional larynx, in the absence of disease. Patients need to be carefully counselled about the subsequent impact on function. A single case study suggested that this procedure effected little change in the type of diet the patient was able to take. In our own sample, the majority of patients (n=7) were able to take liquids following laryngectomy. Therefore, it may be considered for patients with intractable severe aspiration but patients again need careful counselling with respect to their expected swallowing outcome.

**Summary**
CRT is an organ preserving treatment, but at the cost of significant short and long-term swallowing problems. Patients need to be monitored carefully throughout treatment and beyond. Patients should be prepared prior to CRT for the potential impact on eating and drinking. Rehabilitation should start early, including interventions for swallowing impairment and addressing adjustments to living with a chronic condition. Further methodologically sound studies on interventions for dysphagia are needed for this population.

**Conflict of Interest**
All authors have no conflict of interest to declare. No extraneous funding was obtained.

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**Key learning points**
- Swallowing is multi-dimensional and dysphagia outcomes have included measures of swallow physiology, diet textures, patient report, presence of a feeding tube.
- CRT results in deterioration of swallowing function, with some patients improving over time, but others do not.
- Multiple variables impact on swallowing outcomes such as time post-treatment, type of treatment, pre-treatment swallowing status.
- Patients referred for CRT should be seen by a speech and language therapist for a swallowing evaluation.
- Interventions for post-CRT dysphagia are based on challenging fibrosis through movement of the swallowing mechanism.

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**References**
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