Analysis of speech and swallowing and quality of life in patients undergoing subtotal glossectomy with free flap reconstruction followed by radiotherapy

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ABSTRACT
Six patients (4 with post-operative radiotherapy, 2 without) were formally assessed by a speech and language therapist 12 months post-operatively. Patient-reported quality of life (QOL) was simultaneously measured. Patients treated with post-operative radiotherapy had lower overall speech comprehensibility scores, poorer swallowing function in puree and solid foods and lower overall QOL.

Introduction
Surgical resection followed by free flap tongue reconstruction for tongue cancer carries significant morbidity, furthered by adjuvant radiotherapy (RT) [1–3]. While traditionally the emphasis is on surgical outcomes and mortality following cancer resection, quality of life (QOL) is fast becoming an equally important outcome of treatment for both patients and the healthcare team alike [4].

Case series
Six patients that undertook resection with free flap reconstruction for tongue cancer, with or without radiotherapy, were recruited at 12 months post-treatment (Table 1, Figures 1 and 2). Exclusion criteria included base of the tongue resection, prior compromised speech and swallowing function, prior oral surgery, prior head and neck radiotherapy.

Speech, language and swallowing assessment
All patients undertook a one-hour one-to-one assessment with a qualified speech and language therapist. Speech function was assessed by asking the patient to read out words and sentences from a template that use all of the vowels, diphthong tokens and alveolar sibilants. Any inability to pronounce these was recorded, and an overall speech intelligibility score was allocated (from 0% to a perfect intelligibility score of 100%).

The mobility of the tongue was examined, and swallowing function was assessed via the ability to swallow a food bolus completely in all three formations (liquid, pureed and solids) in the absence of residue, coughing or choking, or tearing.

In the two non-irradiated patients, an excellent or near-excellent articulation of phonetic sibilants and speech intelligibility was observed (Table 2). Tongue movements were near-normal, with the absence of the ability to perform circular movements only. Swallowing liquids was excellent in both patients, with some minor residue during pureed and solids noticed in only one of the patients.

In the radiotherapy group, significant articulation defects of multiple phonetic sibilants and speech intelligibility was observed (Table 2). Tongue movements were near-normal, with the absence of the ability to perform circular movements only. Swallowing liquids was excellent in both patients, with some minor residue during pureed and solids noticed in only one of the patients.
patients, but incomplete clearing of the mouth was noted during pureed and solids.

Quality-of-life assessment
All six patients completed the European Organization for Research and Treatment of Cancer Quality of Life Questionnaires (EORTC-QLQ) and EORTC-H&N35, which assesses symptoms specific to head and neck cancers. Patients who did not undergo radiotherapy reported higher overall QOL and better social and sexual functioning (Table 3). They also reported less pain, swallowing problems, speech problems, trouble with social eating and dry mouth (Table 3).

Discussion
The functional decline observed in these patients caused by radiotherapy is due to its adverse effects on the free flap reconstruction and to the other structures of the oral cavity.
Large reconstructed tongues result in better swallowing function and speech outcomes [5,6]. Flap contraction is a known phenomenon in reconstructive surgery, and during tongue reconstruction it is suggested that an over-correction of 20–30% should be performed to compensate for this volume loss [7]. Radiotherapy following tongue reconstruction results in much greater flap contraction. At one-year post-operatively, magnetic resonance imaging scan analysis estimates the volume loss in irradiated patients is 44.2% (16 cm³) compared to 19.8% in the no-radiotherapy group (6.9 cm³), which may explain in part the findings of our study [8].

Radiotherapy is also associated with insults to other structures of the oral cavity that explain the poorer results in speech and language in tongue cancer survivors. Salivary gland atrophy and subsequent saliva deficiency causes xerostomia, which was a prevalent

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**Table 2. Background Information.**

| Patient Number, gender and age (yrs) | Histological Diagnosis | Staging (TNM classification) | Operation | Tongue defect size (% of total surface area) | Free flap reconstruction | Post-operative Radiotherapy |
|-------------------------------------|------------------------|-----------------------------|-----------|---------------------------------------------|-------------------------|---------------------------|
| Patient 1 Male, 58                  | Squamous cell carcinoma| T3N1M0                      | Lt partial glossectomy and right sided lymph node clearance | 40%                          | Radial Forearm flap       | No                        |
| Patient 2 Male, 47                  | Squamous cell carcinoma| T2N0M0                      | Rt partial glossectomy and right sided lymph node clearance | 40%                          | Radial Forearm flap       | No                        |
| Patient 3 Female, 42                | Squamous cell carcinoma| T3N1M0                      | Rt hemiglossectomy and right sided lymph node clearance and selective left sided lymph node clearance | 50%                          | Radial Forearm flap       | Yes                       |
| Patient 4 Female, 27                | Squamous cell carcinoma| T4N1M0                      | Left partial glossectomy with right sided lymph node clearance and selective left sided lymph node clearance | 40%                          | Radial Forearm flap       | Yes                       |
| Patient 5 Female, 61                | Squamous cell carcinoma| T4N0M0                      | Right partial glossectomy with right sided lymph node clearance | 40%                          | Anterolateral thigh flap  | Yes                       |
| Patient 6 Female, 53                | Squamous cell carcinoma| T3N1M0                      | Left partial glossectomy with left sided lymph node clearance and selective left sided lymph node clearance | 40%                          | Anterolateral thigh flap  | Yes                       |

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**Figure 2.** Pre-operative and post-operative outcome of tongue reconstruction utilising the radial forearm free flap.
complaint in the radiotherapy group in our study, and subsequent difficulties in swallowing [9]. Subcutaneous fibrosis and mucosal oedema also have a direct effect on speech and swallowing and subsequently on the quality of life [10].

Our study highlights the negative effects of postoperative radiotherapy in free flap tongue reconstruction, and plastic surgeons who perform these operations should be aware of these during patient counselling and pre-operative planning. In light of evidence that post-operative radiotherapy reduces flap volume by over 40%, an overcorrection of 1.4 may be appropriate for patients undertaking this adjunct therapy. The authors, however, believe that this overcorrection should be preferred in consideration of the projected prognosis. Patients with projected good prognosis may be the ideal candidates for such an overcorrection, whereas those with poorer prognosis may not be, despite radiotherapy, due to the immediate post-operative adverse effects of a large flap in speech, language and quality of life in the short term (first 12 months after resection). Lastly, the side effects of reduced mobility and subsequent tongue functional impairment may potentially be mitigated by the use of re-innervated flaps, a technique which was not utilised in this study [11]. These flaps provide a sensory and mobility element to the reconstructed neo-tongue and may result in an acceptable quality of life despite the use of radiotherapy.

Disclosure statement
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Table 3. Patient responses to EORTC-C30 and EORTC-H&N35 questionnaires.

|                      | Patient 1 (%) | Patient 2 (%) | Patient 3 (%) | Patient 4 (%) | Patient 5 (%) | Patient 6 (%) |
|----------------------|---------------|---------------|---------------|---------------|---------------|---------------|
| **Global Health Status** |               |               |               |               |               |               |
| Global Health Status/QoL | 83.33         | 100.00        | 0.00          | 83.33         | 66.67         | 66.67         |
| **Functional Scales**   |               |               |               |               |               |               |
| Physical Functioning    | 100.00        | 100.00        | 100.00        | 100.00        | 100.00        | 100.00        |
| Role Functioning        | 100.00        | 100.00        | 100.00        | 100.00        | 100.00        | 100.00        |
| Emotional functioning   | 100.00        | 100.00        | 100.00        | 100.00        | 100.00        | 100.00        |
| Cognitive functioning   | 100.00        | 100.00        | 100.00        | 100.00        | 100.00        | 100.00        |
| Social functioning      | 100.00        | 100.00        | 100.00        | 100.00        | 100.00        | 100.00        |
| **Symptom scales/items**|               |               |               |               |               |               |
| Fatigue                | 0.00          | 0.00          | 0.00          | 33.33         | 33.33         | 11.11         |
| N&V                   | 0.00          | 0.00          | 0.00          | 16.67         | 0.00          | 16.67         |
| Pain                   | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Dyspnoea               | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Insomnia               | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Appetite loss          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Constipation           | 0.00          | 0.00          | 0.00          | 100.00        | 66.67         | 66.67         |
| Diarrhoea              | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Financial Difficulties | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| **H&N35**              |               |               |               |               |               |               |
| Pain                   | 0.00          | 8.33          | 8.33          | 16.67         | 33.33         | 25.00         |
| Swallowing             | 0.00          | 0.00          | 8.33          | 8.33          | 16.67         | 8.33          |
| Senses problems        | 0.00          | 0.00          | 16.67         | 33.33         | 33.33         | 16.67         |
| Speech problems        | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Trouble with social eating | 8.33  | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Trouble with social contact | 0.00 | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Less sexuality         | 0.00          | 0.00          | 33.33         | 33.33         | 66.67         | 83.33         |
| Teeth                  | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Opening of mouth       | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Dry mouth              | 0.00          | 0.00          | 66.67         | 66.67         | 66.67         | 66.67         |
| Sticky Saliva          | 0.00          | 0.00          | 0.00          | 66.67         | 66.67         | 66.67         |
| Coughing               | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Felt ill               | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Pain Killers           | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Nutritional Supplements | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Feeding tube           | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
| Weight Loss            | 0.00          | 0.00          | 0.00          | 100.00        | 0.00          | 0.00          |
| Weight gain            | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          | 0.00          |
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