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COMPARISON OF SURGICAL MARGINS IN TONGUE SQUAMOUS CELL CARCINOMA EXCISION WITH AND WITHOUT RADIAL FOREARM FREE FLAP RECONSTRUCTION: A RETROSPECTIVE STUDY FROM A PORTUGUESE CANCER CENTER

COMPARACIÓN DE LOS MÁRGENES QUIRÚRGICOS EN LA ESCISIÓN DEL CARCINOMA ESCAMOSO DE LENGUA CON Y SIN RECONSTRUCCIÓN CON COLGAJO LIBRE DE ANTEBRAZO RADIAL: UN ESTUDIO RETROSPECTIVO DE UN CENTRO ONCOLÓGICO PORTUGUÊS

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ABSTRACT

Introduction: Clear surgical margins are crucial in treating oral tongue squamous cell carcinoma (OTSCC), as they significantly influence survival rates. However, achieving these margins can be tricky since resections can affect essential functions like speech and swallowing. That is where free tissue transfer comes in, especially the radial forearm free flap (RFFF), which allows more complex reconstructions and gives surgeons the flexibility to aim for wider resections. The question of whether this leads to better oncologic safety is still up for debate.

Patients and methods: In our *retrospective study*, we looked back at 94 patients who had partial, hemi-, or subtotal glossectomy for OTSCC at a cancer center in Portugal from 2017 to 2024. Most of the patients were male (n = 64; 68.1 %), with an average age of 66.4 years.

Results: We found that primary closure was done in 72 cases (76.6 %), while 22 patients (23.4 %) needed RFFF reconstruction. The average shortest margin was 5.0 mm, but we noticed that margin width significantly decreased with more advanced pathological stages. While margins were a bit narrower in the RFFF group compared to primary closure (4.0 mm vs. 5.3 mm), this difference was not statistically significant. It is worth noting that RFFF was more commonly used in advanced-stage tumors.

Conclusion: Our findings underscore the challenges of achieving safe margins in tongue cancer and emphasize how tumor stage impacts surgical outcomes. Although RFFF did not independently enhance margin clearance, it did offer the reconstructive options needed for radical resections in tough cases, reinforcing its valuable role in multidisciplinary treatment approaches.

Keywords: Squamous Cell Carcinoma, Surgical Margins, Glossectomy, Tongue Neoplasms, Flap Reconstruction, *Radial forearm free flap.*

RESUMEN

Introducción: Los márgenes quirúrgicos claros son esenciales en el tratamiento del carcinoma escamoso de lengua oral (CELO), ya que influyen significativamente en la supervivencia. Alcanzar márgenes adecuados es complicado, porque las resecciones pueden afectar funciones críticas como el habla y la deglución. La transferencia de tejido libre, especialmente el colgajo libre de antebrazo radial (RFA), permite reconstrucciones complejas y resecciones más amplias, aunque su impacto en la seguridad oncológica sigue siendo debatido.

Pacientes y métodos: Se realizó un estudio retrospectivo de 94 pacientes sometidos a glossectomía parcial, hemi o subtotal por CELO en un centro oncológico portugués entre 2017 y 2024. Se recopilaron datos demográficos, clínicos y quirúrgicos,

incluyendo tipo de cierre y medidas de los márgenes quirúrgicos.

Resultados: La mayoría de los pacientes eran hombres (68,1 %) con edad media de 66,4 años. Se realizó cierre primario en el 76,6 % de los casos, mientras que el 23,4 % requirió reconstrucción con RFA. El margen quirúrgico más corto promedio fue de 5,0 mm, disminuyendo significativamente en estadios patológicos avanzados. Los márgenes fueron ligeramente más estrechos en el grupo RFA que en el cierre primario (4,0 mm *vs.* 5,3 mm), aunque esta diferencia no fue significativa. El RFA se utilizó con mayor frecuencia en tumores avanzados.

Conclusión: Estos resultados destacan la dificultad de lograr márgenes seguros en cáncer de lengua avanzado y el efecto del estadio tumoral en los resultados quirúrgicos. Aunque el RFA no mejoró de forma independiente la limpieza de márgenes, proporcionó opciones reconstructivas clave para resecciones radicales, reforzando su papel en enfoques multidisciplinarios.

Palabras clave: Carcinoma de células escamosas, márgenes quirúrgicos, glossectomía, neoplasias de la lengua, reconstrucción con colgajo, colgajo libre de antebrazo radial.

INTRODUCTION

Oral cavity cancers are a worldwide problem that includes tongue cancers and other quintessential cancers of the mouth. These cancers are estimated to increase tremendously in the upcoming decade which will add further burden on the worldwide health care[1-4]. The disease of tongue cancer is highly correlated with risk factors of lifestyle i.e. smoking and drinking[2].

Surgery is still the main means of treating oral squamous cell carcinoma (OSCC), and to a vital degree the ability to excise the cancer, with adequate safe margins, is critical in minimizing the chance of recurrence and improving survival[1-3,5-11]. The margins of the tumor are assessed on pathological examination and evaluation constitutes a long-standing criterion to evaluate the tumor removal. Margins are typically categorized as positive (< 1 mm), close (1-5 mm), or clear (> 5 mm), and their status often guides the need for further treatment such as radiotherapy or chemotherapy[1,3,9,12].

However, surgical excision—especially of the tongue—often results in significant loss of tissue, which can impair vital functions including speech and swallowing[2,13,14]. In more extensive cases, reconstructive techniques using free tissue transfer have become essential to restore volume and function[13-16]. The radial forearm free flap (RFFF) is one of the most commonly used techniques due to its reliability and adaptability[13,14].

Some clinicians argue that the ability to perform flap reconstruction may influence the aggressiveness of tumor resection, permitting the surgeons to remove tumors more freely without being constrained by closure concerns[5,16-18]. This could theoretically improve oncologic outcomes by increasing the likelihood of achieving tumor-free margins[2,18]. Despite this possibility, the literature remains limited regarding whether flap reconstruction, is truly associated with better margin clearance in tongue cancer surgery.

This retrospective study, conducted at a Portuguese cancer center, aims to compare the surgical margin status in patients undergoing glossectomy, distinguishing between those treated with primary closure and those reconstructed with a radial forearm free flap. The objective is to understand whether the reconstructive approach has any measurable impact on oncologic safety, as reflected by margin outcomes.

METHODS

This retrospective cohort study was conducted at a tertiary oncological center and included patients with a histopathological diagnosis of oral squamous cell carcinoma (OSCC), confirmed through incisional biopsy, who subsequently underwent partial glossectomy, hemiglossectomy, or subtotal glossectomy.

Preoperative evaluation comprised clinical history, physical examination, complete blood count, serum biochemistry, and imaging studies, such as magnetic resonance imaging (MRI) or computed tomography (CT) of the head, neck. In patients with stage cT3 or higher disease, a chest CT scan was also performed to exclude distant metastasis. Surgical resection was the primary treatment modality in all cases, followed by adjuvant therapy when indicated.

Patients were included in the study if they were above the age of 18, had undergone surgery from December 1, 2017, to July 31, 2024, and had their surgical specimens evaluated by the pathology department of the same institution. Also, the histopathological report was required to include specific information regarding surgical margin status. Patients were excluded if the histopathological assessment had been performed externally, if the procedure consisted solely of margin widening, if there was loco-regional recurrence at the time of surgery, or if intraoperative frozen section analysis had been performed.

Information concerning age, sex, date of surgery, and surgical margin status, along with pathological tumor stage (pT stage) according to the TNM Classification of Malignant Tumours, Eighth Edition[19], was retrieved from electronic medical records. When available, the shortest surgical margin and its anatomical location were documented. Patients were divided into two groups according to the type of reconstruction: primary closure or local flap (glossoplasty) versus radial forearm free flap (RFFF) reconstruction. For patients who underwent RFFF reconstruction, the surgical teams who performed tumor resection and flap harvest and flap reconstruction were distinct.

Statistical analysis was performed using SPSS software version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize patient demographics and clinical characteristics. Surgical margin lengths showed non-normal distribution, confirmed by both Shapiro-Wilk and Kolmogorov-Smirnov tests ($p < 0.001$), so we analyzed these measurements using non-parametric tests (Kruskal wallis test and Mann whitney test).

The Kruskal-Wallis test was used to compare surgical margin lengths across multiple groups, such as type of surgery, type of reconstruction, and pathological stage (pT). When significant differences were found, pairwise comparisons with Bonferroni correction were performed. A two-sided p-value of <0.05 was considered statistically significant. For all comparisons, the shortest surgical margin recorded per case was used as the primary variable.

All margin measurements reported in the final histopathological assessment were documented; however, for statistical comparison, only the shortest margin was

considered.

RESULTS

Initially, 112 patients met the diagnosis and surgery criteria. Of these, 18 patients were excluded for the following reasons: histopathological analysis performed outside the institution (n = 7), procedures consisting solely of margin widening (n = 5), presence of loco-regional recurrence at the time of surgery (n = 4), and the use of intraoperative frozen section analysis (n = 2).

A total of 94 patients were included in this study, with a mean age of 66.4 years (SD = 14.5; range: 20-94 years). The majority were male (n = 64; 68.1 %). Regarding pathological staging, tumors were most frequently classified as pT2 (n = 34; 36.2 %) and pT3 (n = 32; 34.0 %) (Table I).

Hemiglossectomy was the most performed surgical procedure (n = 74; 78.7 %), followed by partial glossectomy (n = 18; 19.1 %**)** and subtotal glossectomy (n = 2; 2.1 %**)**. Concerning reconstruction, 72 of patients (76.6 %) underwent primary closure/glossoplasty, while 22 (23.4 %) required radial forearm free flap (RFFF) reconstruction**.**

The mean shortest surgical margin was 5.02 mm (SD = 3.37), with a median of 4.0 mm and a range from 0.9 to 16.0 mm. The most frequently involved anatomical location of the shortest margin was the medial margin (n = 34; 39,1 %)**,** followed by the deep margin (n = 24; 27,6 %).

Comparison of margins by type of resection

We observed no statistically significant differences in the shortest surgical margin across the different types of resection (partial, subtotal, and hemiglossectomy) (Kruskal-Wallis test, p = 0.442). Hemiglossectomy showed the largest mean margin (5.2 mm), while subtotal glossectomy had the smallest (3.0 mm).

Comparison of margins by pathological tumor stage (pT)

Statistically significant difference in margin length among pathological tumor stages was found (Kruskal-Wallis test, p = 0.034). Patients with early-stage tumors (pT1 and pT2) showed higher mean margins (5.6 mm and 5.5 mm, respectively), while those with advanced-stage tumors, particularly pT4, had significantly narrower margins (1.9 mm). Pairwise comparisons showed significant differences between pT4 and pT1, as well as pT4 and pT2. These differences did not remain statistically significant after Bonferroni correction, though.

Comparison of margins by type of reconstruction

Although patients who underwent primary closure exhibited a higher mean margin (5.3 mm) compared to those reconstructed with RFFF (4.0 mm), this difference did not reach statistical significance (Kruskal-Wallis test, p = 0.068).

Association between type of reconstruction and pathological tumor stage

Cross-tabulation of type of reconstruction and pathological stage revealed a statistically significant association (Pearson's χ^2 = 10.024, p = 0.044). The RFFF was more frequently used in advanced-stage tumors (pT3 and pT4a), whereas primary closure was more common in early-stage tumors (pT1 and pT2). Residuals analysis supports these findings, with positive adjusted residuals in the RFFF group for pT3 and pT4a, and in the primary closure group for pT1 and pT2.

DISCUSSION

Surgical resection serves as the primary treatment for oral cavity malignancies, with achieving histologically negative margins as the main goal. Insufficient or close surgical margins are consistently link to higher local recurrence rates and worse overall outcomes[1,3,8-10]. The tongue's mobility and muscular structure provide relative surgical flexibility, allowing more generous resections compared to other intraoral sites.

However, surgeons often take a conservative approach to preserve speech and swallowing functions. In this context, free tissue transfer offers a reconstructive advantage, enabling radical tumor ablation while maintaining or restoring function and aesthetics[20].

In our series, we didn't see any positive margins. That actually matters, since studies usually report margin involvement in tongue cancer anywhere from 5% to 25%. So, our results really show we hit a solid level of oncologic safety[11,18,21,22].

Our patient group showed a male predominance (68.1 %), consistent with previous studies. For example, Lu et al. reported 84.7 % male patients in a Taiwanese population, while Garg et al. and Vincent et al. documented similarly high male proportions, confirming the gender disparity typically seen in tongue cancer[4,5,20].

The mean age at diagnosis in our cohort was 66.4 years, notably higher than other reported studies. Lu et al. and Garg et al. reported mean or median ages of 53 and 50 years, respectively, while Vincent et al. observed a mean age of 59.2 year[4,5,20]. This difference suggests regional or demographic differences, possibly reflecting population aging or healthcare access differences.

We observed a significant inverse relationship between pathological T stage and surgical margin width. Mean margin width decreased progressively from 5.6 mm in pT1 to just 1.9 mm in pT4 tumors (p = 0.044), supporting the idea that achieving clear margins becomes increasingly difficult as tumor burden and anatomical involvement escalate. This finding matches multiple prior studies[3,7], which attribute margin compromise in advanced tumors to factors such as anatomical distortion, proximity to vital structures, and infiltrative growth patterns.

Some authors have argued that smaller margins may be acceptable in early-stage disease, but our data showed variability in margin status even in pT1 and pT2 tumors. This finding supports conclusions from Bungum's systematic review[3] that margin adequacy is not guaranteed in early disease and remains a critical prognostic factor regardless of T stage. Individualized margin assessment and intraoperative vigilance remain essential.

Regarding reconstruction method's influence on margin status, our findings showed a non-significant difference between groups: mean margin width was slightly higher in

the primary closure group (5.3 mm) compared to the RFFF group (4.0 mm), though this did not reach statistical significance (p = 0.068). These results are consistent with studies by Garg et al., El-Shabrawi et al., and Vicente et al., all finding no statistically significant association between reconstruction modality and surgical margin clearance[2,5].

Some studies, such as Hanasono et al.[17], suggest that free flap reconstruction availability enables more aggressive tumor excision by reducing primary closure constraints. However, in our setting, the oncologic and reconstructive phases are performed by separate surgical teams. This division may diminish the influence of reconstructive planning on margin decisions during resection, possibly explaining the lack of significant difference in our data. In this model, the ablative surgeon may focus solely on oncologic priorities without tailoring resections to fit anticipated flap design.

The ability to reconstruct large, complex defects with free tissue transfer theoretically permits more extensive resections, potentially improving local control.

Regarding anatomical location, the shortest surgical margin in our series most frequently corresponded to the medial margin (30.9 %), followed by the deep margin (20.2 %). These findings differ from those reported by Thake et al., who found that the inferior/lateral mucosal margin was most commonly close or involved, followed by the deep margin, with medial margins involved in only 11 % of cases[21]. Iseli et al. reported a relatively equal distribution of close/involved margins across anatomical directions, with no statistically significant differences between anterior and posterior, lateral and medial, or mucosal and deep sites[22]. Despite some variation among studies, the deep margin consistently emerges as a frequent site of minimal clearance and is particularly relevant given its association with recurrence. Poissonnet et al. demonstrated that a deep margin ≥ 3 mm in T1-T2 tumors and ≥ 5 mm in T3-T4 tumors significantly improved recurrence-free and overall survival, further supporting the clinical importance of deep margin assessment[23]. Our findings, showing the deep margin as the second most commonly involved site, align with this evidence and highlight the need for meticulous resection planning in both medial and deep planes to optimize oncologic outcomes.

Several limitations must be acknowledged. The retrospective design introduces potential selection and documentation biases. The limited sample size may have reduced the power to detect statistically significant associations in subgroup analyses. Additionally, margin status is influenced by subjective factors, including surgical experience and intraoperative judgment, which introduces variability difficult to control in retrospective studies. Still, when it comes to measuring margin width and location under the microscope, it's not always the same story. Different pathologists—and even the same pathologist at different times—might judge things a bit differently. That kind of variability just comes with the territory when you're looking back at cases like this. Moreover, external factors such as limited availability of resources for free flap reconstruction and delays between imaging and surgery—often due to waiting lists and rapid disease progression—may have influenced reconstructive strategy and, in some cases, the ability to achieve optimal surgical margins.

In conclusion, this study reinforces the complex interplay between tumor stage, surgical planning, and reconstructive strategy in the management of tongue carcinoma. Our data confirm a statistically significant reduction in surgical margin width with advancing pathological T stage, underscoring the inherent difficulty in achieving wide excision in more advanced disease. Although the use of radial forearm free flap reconstruction did not significantly affect margin status in our cohort, the observed trends suggest that reconstructive options may enable more aggressive resections when integrated into preoperative planning. Independent of the statistical outcomes, it is important to emphasize that the radial forearm free flap remains a reconstructive method of choice for tongue defects due to its excellent pliability, reliable vascularity, and well-documented potential for functional recovery, particularly in terms of speech articulation and swallowing dynamics.

What distinguishes this study is the surgical model in which the resection and reconstruction are performed by different surgical teams, potentially insulating the oncologic decision-making process from reconstructive limitations. This unique institutional dynamic offers a novel perspective: that the separation of roles may preserve oncologic radicality independent of reconstructive complexity. Further prospective studies are warranted to assess whether integrated or segmented surgical

workflows influence margin status and oncologic outcomes in oral cancer surgery.

Conflict of interest and funding

The authors declare that there are no conflicts of interest and no financial support for this study.

This work has not been previously presented at any conferences or seminars, either orally or in written form.

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Table I. Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Age ≥ 18 years	Histopathological analysis performed outside the institution
Underwent surgery between December 1, 2017, and July 31, 2024	Surgical procedure limited to margin widening
Histologically confirmed diagnosis of oral squamous cell carcinoma via incisional biopsy	Presence of loco-regional recurrence at the time of surgery
Underwent partial glossectomy, hemiglossectomy, or subtotal glossectomy	Intraoperative frozen section analysis performed
Histopathological report included assessment of surgical margin status	—

Table II. Patient demographics and clinical characteristics (n = 94).

Variable	**Category**	**N (%)**
Age (years)	Mean (SD)	66.4 (± 14.5)
	Range	20-94
Sex	Male	64 (68.1 %)
	Female	30 (31.9 %)
Type of Surgery	Hemiglossectomy	74 (78.7 %)
	Partial glossectomy	18 (19.1 %)
	Subtotal glossectomy	2 (2.1 %)
Type of Reconstruction	Primary closure	72 (76,6 %)
	Radial forearm freee fap (RFFF)	22 (23,4 %)

Figure 1. Comparison of margins by pathological tumor stage (pT).