Section: Radiodiagnosis

Original Research Article

ROLE OF MRI AND HRUSG IN THE EVALUATION OF CARCINOMA OF TONGUE AND CERVICAL LYMPHNODE METASTASIS

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ABSTRACT

Background: Carcinoma of the tongue is the most common oral cavity malignancy and frequently presents with early cervical lymph node metastasis. Accurate preoperative imaging is essential for staging and treatment planning. This study evaluated the role of magnetic resonance imaging (MRI) and high-resolution ultrasonography (HRUSG) in assessing carcinoma of the tongue and cervical lymph node metastasis. **Materials and Methods:** This retrospective study was conducted in the Department of Radiodiagnosis, SUT Academy of Medical Sciences, Trivandrum, between August 2024 and August 2025. Twenty-five patients with biopsy-proven squamous cell carcinoma of the tongue were included. All patients underwent plain and contrast-enhanced MRI of the tongue and neck, while 15 patients additionally underwent HRUSG of the tongue using the tongue-touch technique. HRUSG of the neck was performed in all patients for lymph node characterization. Imaging findings were analyzed using descriptive statistics. **Results:** The lateral border of the tongue was the most common site of involvement (56%). MRI accurately demonstrated tumor extent, including base of tongue involvement (32%), floor of mouth extension (24%), and crossing of the midline (44%). T2N2 was the most common stage (52%). HRUSG accurately measured mediolateral tumor thickness in superficial lesions but showed limitations in assessing posterior extension and deep invasion. HRUSG demonstrated superior qualitative characterization of cervical lymph nodes, particularly metastatic nodes measuring less than 1 cm. **Conclusion:** MRI is the preferred imaging modality for local staging and assessment of tumor extent in carcinoma tongue. HRUSG complements MRI by accurately evaluating superficial tumors and improving characterization of cervical lymph nodes. The combined use of MRI and HRUSG enhances preoperative staging and assists in selecting appropriate treatment strategies.

INTRODUCTION

Squamous cell carcinoma (SCC) of the tongue is the most common malignancy of the oral cavity and accounts for a significant proportion of head and neck cancers. It is characterized by aggressive local invasion and a marked tendency for early cervical lymph node metastasis, both of which adversely affect survival and prognosis. The presence of regional nodal disease is the single most important prognostic factor influencing recurrence, treatment outcomes, and overall survival. Therefore, accurate preoperative evaluation of the primary tumor and cervical lymph nodes is essential for appropriate TNM staging, surgical planning, and selection of adjuvant therapy.[1,2]

Among the available imaging modalities, magnetic resonance imaging (MRI) is widely regarded as the gold standard for local assessment of carcinoma tongue because of its superior soft-tissue contrast resolution and multiplanar imaging capability. MRI provides excellent delineation of the primary tumor, accurately evaluates tumor size, depth of invasion, tumor thickness, crossing of the midline, involvement of the floor of the mouth, base of the tongue, adjacent muscles, mandible, and neurovascular structures. These imaging findings are critical in determining tumor stage, resectability, and the extent of surgical excision required.[3,4]

High-resolution ultrasonography (HRUSG) has emerged as a valuable adjunctive imaging modality, particularly for superficial carcinomas involving the anterolateral border and tip of the tongue. The use of high-frequency linear transducers with the trans-cheek (tongue-touch) technique allows excellent visualization of superficial lesions and accurate measurement of tumor thickness in real time. HRUSG is non-invasive, radiation-free, cost-

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effective, readily available, and can be repeated whenever required. In addition, it provides dynamic assessment and has shown promising results in evaluating superficial tumor extent that may not always be clearly appreciated clinically.[5,6]

Evaluation of cervical lymph node metastasis remains an integral part of preoperative staging because nodal involvement significantly alters treatment strategy and prognosis. MRI effectively identifies enlarged metastatic lymph nodes and assesses deep cervical nodal stations; however, HRUSG offers superior characterization of smaller lymph nodes by evaluating nodal morphology, cortical thickness, echotexture, fatty hilum, necrosis, and vascularity. Consequently, the combined use of MRI and HRUSG improves the overall diagnostic accuracy for both primary tumor assessment and cervical nodal evaluation, thereby facilitating better treatment planning and patient management.[7]

Therefore, the present study was undertaken to evaluate the role of MRI and HRUSG in biopsy-proven carcinoma of the tongue, assess the diagnostic value of MRI in tumor staging, determine the usefulness of HRUSG in superficial lesions involving the anterolateral aspect and tip of the tongue, compare both modalities in cervical lymph node characterization, and evaluate their combined role in guiding appropriate clinical management.

MATERIALS AND METHODS

Study Design

This was a retrospective observational study conducted to evaluate the role of magnetic resonance imaging (MRI) and high-resolution ultrasonography (HRUSG) in the assessment of biopsy-proven carcinoma of the tongue and cervical lymph node metastasis.

Study Setting

The study was conducted in the Department of Radiodiagnosis, SUT Academy of Medical Sciences (SUTAMS), Trivandrum, Kerala, in collaboration with the Department of Otorhinolaryngology.

Study Period

The study included patients evaluated between August 2024 and August 2025.

Study Population

A total of 25 consecutive patients with histopathologically confirmed squamous cell carcinoma (SCC) of the tongue were included in the study.

Inclusion Criteria

- Patients with biopsy-proven squamous cell carcinoma of the tongue.
- Patients referred for MRI evaluation of the tongue and neck.
- Patients with complete imaging records available for analysis.

Exclusion Criteria

- Patients with recurrent carcinoma of the tongue following previous treatment.
- Patients with contraindications to MRI or gadolinium-based contrast agents.
- Patients with incomplete imaging data or poor-quality examinations.
- Patients with non-squamous histological variants of tongue malignancy.

Data Collection

Clinical records and imaging findings were reviewed retrospectively.

- All 25 patients underwent plain and contrast-enhanced MRI of the tongue and neck for assessment of the primary lesion and cervical lymph nodes.
- Fifteen of the 25 patients additionally underwent HRUSG of the tongue using the trans-cheek (tongue-touch) technique.
- All 25 patients underwent HRUSG of the neck for characterization of cervical lymph nodes.

The imaging findings were recorded systematically and correlated with tumor extent and nodal involvement.



Figure 1: HRUSG of Tongue (linear probe 7 to 12 MHz)

MRI Protocol

MRI examinations were performed using routine head and neck imaging protocols.

Sequences included:

- Coronal T1-weighted images
- Coronal STIR images
- Axial T2-weighted images
- Axial STIR images
- Sagittal T2-weighted images
- Sagittal STIR images
- Post-contrast axial, coronal, and sagittal fat-suppressed T1-weighted images

Field of View (FOV):

From the thoracic inlet to the supraorbital rim.

MRI evaluation included:

- Tumor site
- Tumor size
- Depth of invasion
- Mediolateral tumor thickness
- Crossing of the midline
- Base of tongue involvement
- Floor of mouth extension
- Mandibular invasion
- Adjacent soft tissue involvement
- Cervical lymph node staging according to TNM criteria.

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HRUSG Technique

High-resolution ultrasonography was performed using a 7–12 MHz linear-array transducer.

For tongue examination, the tongue-touch technique was employed:

- The patient was positioned supine with a pillow under the neck to obtain optimal head extension.
- The patient was instructed to touch the buccal mucosa of the corresponding cheek with the tongue.
- The transducer was placed externally over the cheek (trans-cheek approach) to evaluate the tongue lesion.

HRUSG assessment included:

- Tumor localization
- Mediolateral tumor thickness
- Tumor margins
- Depth of invasion in superficial lesions

Cervical lymph node morphology:

- Short-axis diameter
- Shape
- Hilum
- Echogenicity
- Necrosis
- Calcification
- Vascularity

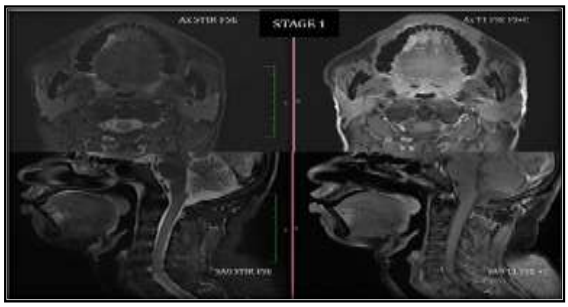


Figure 2: Axial and sagittal STIR and post-contrast T1-weighted MRI images demonstrating a small localized lesion involving the tongue/oral cavity, consistent with Stage I disease

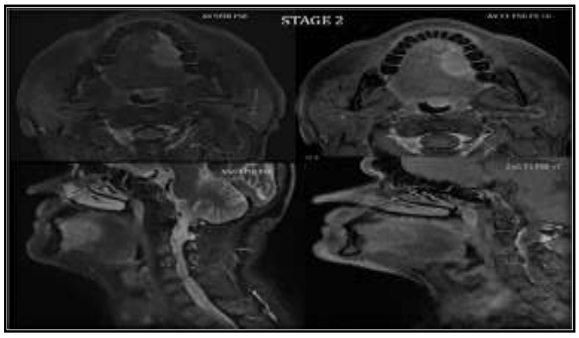


Figure 3: Axial and sagittal STIR and post-contrast T1-weighted MRI images demonstrating an enhancing lesion involving the tongue/oral cavity, consistent with Stage II disease

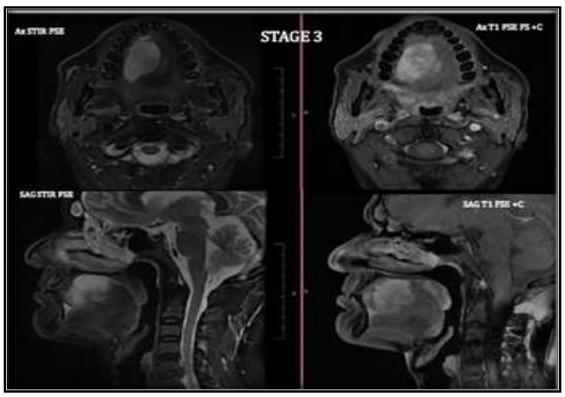


Figure 4: Axial and sagittal STIR and post-contrast T1-weighted MRI images demonstrating an enhancing infiltrative lesion involving the tongue/oral cavity, consistent with locally advanced (Stage III) disease

Outcome Measures

The primary outcome measures were:

- Diagnostic value of MRI in tumor staging.
- Role of HRUSG in evaluating superficial carcinoma involving the anterolateral aspect and tip of the tongue.
- Comparison of MRI and HRUSG in cervical lymph node characterization.
- Utility of combined MRI and HRUSG findings in preoperative treatment planning.

Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using descriptive statistical methods. Results were expressed as frequencies, percentages, ratios, and proportions and presented in tables and charts.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Ethics Committee of SUT Academy of Medical Sciences, Trivandrum, prior to commencement of the study. Patient confidentiality was maintained throughout the study, and all data were analyzed anonymously.

RESULTS

A total of 25 patients with biopsy-proven squamous cell carcinoma (SCC) of the tongue were included in the study. MRI was performed in all patients for evaluation of the primary lesion and cervical lymph nodes, while HRUSG of the tongue was performed in 15 patients with superficial lesions and HRUSG of the neck was performed in all 25 patients for lymph node characterization. The imaging findings are summarized below, consistent with the study data.

Table 1: Distribution of Tumor Site in Carcinoma Tongue (n=25)

Site of involvement	Number (n)	Percentage (%)
Lateral border of tongue	14	56.0
Posterior tongue	7	28.0

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Base of tongue	2	8.0
Anterior tongue (Tip)	2	8.0
Total	25	100.0

The lateral border of the tongue was the commonest site of tumor involvement (56%), followed by the posterior tongue (28%). Lesions involving the base and anterior aspect of the tongue were relatively uncommon (8% each).

Table 2: MRI Findings Showing Local Tumor Extension (n=25)

MRI Finding	Number (n)	Percentage (%)
Base of tongue extension	8	32.0
Floor of mouth involvement	6	24.0
Crossing the midline	11	44.0
Posterior extension	4	16.0

MRI demonstrated excellent delineation of local tumor extent. Crossing of the midline was the most frequent imaging finding (44%), followed by extension into the base of the tongue (32%) and floor of the mouth (24%). Posterior extension was identified in 16% of patients.

Table 3: MRI Tumor and Nodal Staging (TNM) (n=25)

MRI Stage	Number (n)	Percentage (%)
T1N0	3	12.0
T1N1	1	4.0
T2N0	1	4.0
T2N2	13	52.0
T3N2	6	24.0
T4N2	1	4.0
Total	25	100.0

Most patients presented with advanced nodal disease, with T2N2 being the predominant stage (52%), followed by T3N2 (24%). Early-stage disease (T1N0 and T1N1) accounted for only 16% of cases, indicating that the majority of patients presented with locally advanced carcinoma.

Table 4: Comparative Role of MRI and HRUSG in Evaluation of Carcinoma Tongue and Cervical Lymph Nodes

Parameter	MRI	HRUSG
Assessment of local tumor extent	Excellent	Good for superficial lesions
Mediolateral tumor thickness	Good	Excellent
Posterior extension	Excellent	Limited
Base of tongue involvement	Excellent	Limited
Floor of mouth involvement	Excellent	Limited
Characterization of lymph nodes <1 cm	Moderate	Excellent
Characterization of lymph node morphology	Good	Excellent
Evaluation of superficial anterolateral/tip lesions	Good	Excellent

MRI was superior for assessing deep tumor extension, involvement of adjacent structures, and overall TNM staging. HRUSG accurately measured mediolateral tumor thickness in superficial lesions and showed superior characterization of cervical lymph nodes, particularly metastatic nodes measuring less than 1 cm. The combined use of MRI and HRUSG improved the overall preoperative assessment of carcinoma tongue and aided treatment planning.

DISCUSSION

Accurate preoperative imaging plays a pivotal role in the management of carcinoma of the tongue, as treatment decisions largely depend on precise assessment of the primary tumor and cervical lymph node metastasis. The present study evaluated the complementary roles of magnetic resonance imaging (MRI) and high-resolution ultrasonography (HRUSG) in biopsy-proven squamous cell carcinoma of the tongue. MRI provided comprehensive evaluation of tumor extent and regional staging, whereas HRUSG proved particularly useful in assessing superficial tongue lesions and improving characterization of cervical lymph nodes. The combined use of both imaging modalities enhanced diagnostic confidence and aided appropriate treatment planning.

HRUSG demonstrated excellent utility in evaluating lesions involving the anterolateral aspect and tip of the tongue. Using the tongue-touch technique with a high-frequency linear transducer, HRUSG accurately localized superficial tumors and provided reliable measurement of mediolateral tumor thickness. These findings are consistent with those of Wakasugi-Sato et al. and Chammas et al., who reported that intraoral and transcutaneous ultrasonography is a simple, non-invasive, and reliable technique for assessing superficial oral tongue carcinomas and estimating tumor thickness, which is an important predictor of cervical nodal metastasis and surgical outcomes.[8,9]

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Depth of invasion and tumor thickness are well-established prognostic indicators in oral tongue squamous cell carcinoma and have been incorporated into modern TNM staging because of their strong association with occult cervical metastasis. In the present study, MRI accurately demonstrated the depth of tumor invasion, extension into the base of the tongue, floor of the mouth involvement, and crossing of the midline. However, HRUSG showed limitations in evaluating deeply situated lesions and posterior extension because of restricted acoustic access. Similar observations were reported by Matos et al., who demonstrated that increasing tumor thickness significantly predicts lymph node metastasis and recurrence, while Noorlag et al., in their systematic review, concluded that although modern imaging modalities improve preoperative assessment of cervical lymph nodes, no single imaging technique provides sufficient diagnostic accuracy to reliably exclude nodal metastasis.[10,11]

Cervical lymph node involvement remains the single most important prognostic factor affecting survival in carcinoma of the tongue. In the present study, HRUSG showed superior qualitative characterization of metastatic lymph nodes, particularly those measuring less than 1 cm, by evaluating nodal morphology, loss of fatty hilum, internal architecture, and necrosis. MRI, on the other hand, provided superior evaluation of deep cervical nodal groups and comprehensive regional staging. These findings are in agreement with Yesuratnam et al., who demonstrated that ultrasonography accurately estimates tumor thickness and depth of invasion in superficial tongue lesions, while MRI provides a more comprehensive assessment of local tumor extent. Tarabichi et al. further emphasized the value of MRI for reliable preoperative assessment of depth of invasion, thereby facilitating appropriate surgical planning.[12,13]

Overall, the findings of the present study indicate that MRI remains the gold standard imaging modality for evaluating carcinoma of the tongue because of its excellent soft tissue contrast and ability to assess local tumor spread, adjacent structure involvement, and TNM staging. HRUSG serves as an important complementary investigation, particularly for superficial anterolateral tongue lesions and characterization of subcentimetric cervical lymph nodes. The complementary use of MRI and HRUSG observed in the present study suggests that combining these modalities enhances preoperative assessment by integrating the superior soft tissue characterization of MRI with the high spatial resolution of ultrasonography for superficial lesions and cervical lymph node evaluation, thereby assisting clinicians in selecting the most appropriate surgical and oncological management strategy.

CONCLUSION

MRI remains the imaging modality of choice for evaluating carcinoma of the tongue because of its superior ability to assess tumor extent, depth of invasion, adjacent structure involvement, and TNM staging. HRUSG is an excellent complementary imaging technique for superficial lesions involving the anterolateral aspect and tip of the tongue, providing accurate measurement of tumor thickness and superior characterization of small cervical lymph nodes. Although HRUSG has limitations in evaluating deep posterior lesions and floor of mouth extension, its ability to detect subcentimetric metastatic lymph nodes enhances preoperative assessment. The combined use of MRI and HRUSG improves diagnostic accuracy, facilitates accurate staging, and aids in planning appropriate surgical and oncological management.

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