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Original Research Article

Role of MRI in Evaluation of Carcinoma of Tongue with Histopathological Correlation

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Abstract:

Background: This study was conducted to evaluate the role of MRI (Magnetic Resonance Imaging) in the evaluation of carcinoma of the tongue with histopathological correlation.

Methods: This study was a prospective hospital-based investigation that involved 50 patients who had been diagnosed with tongue carcinoma based on clinical or biopsy findings. The patients were referred for magnetic resonance imaging from Acharya Harihara Postgraduate Institute of Cancer to the Department of Radiodiagnosis at SCB Medical College and Hospital, Cuttack, Odisha, for a two-year period. The study was approved by the institutional ethics committee, and the participants provided written informed consent.

Results: Almost perfect agreement (k = 0.928) was seen between MRI and histopathological N staging assessment. The mean depth of invasion by histopathology and MRI was found to be 7.848 mm and 8.664 mm respectively. Good agreement (k = 0.851) was found between radiological and pathological tumour depth. Out of fifty cases, 44 (88%) were found to be well differentiated (G1), 4 (8%) moderately differentiated (G2, and 2 (4%) poorly differentiated (G3) squamous cell carcinoma. Lymphovascular invasion was seen in 14 (28%) cases and perineural invasion was seen in 12 (24%) cases. Both lymphovascular and perineural invasions were found in 6 (12%) cases in the post-surgical histopathological study. The worst pattern of invasion was seen in 12 (24%) patients on histopathology.

Conclusion: MRI is the preferred imaging modality for the assessment of tongue carcinoma due to its ability to precisely stage the tumour using the TNM classification system. This staging is essential for optimising treatment choices, such as glossectomy/marginal mandibulectomy, radiation, or both.

Keywords: MRI Evaluation, Carcinoma, Tongue, Histopathological Correlation.

Introduction

Head and neck malignancies are the fifth most common [1] cancers worldwide and include a variety of sites. Among these, oral cancers have a higher incidence, being the 12th most common globally and 8th in developing countries. [2] Almost 90% of head and neck tumors have a squamous histology. [3] The prevalence of squamous cell carcinoma of the oral cavity is higher in the Indian subcontinent, mostly attributed to tobacco chewing, either alone or in combination with lime and betel nuts, along with consumption of ethanol. [2] The five-year survival rate for early cancers of the oral cavity is 68%, falling to 27% in advanced tumours. [2] Distant metastasis ranges from 7 to 23% in head and neck squamous cell carcinoma and is 9.2% for N2 nodal status and 20% for a stage IV disease. [4] The majority of tongue tumours develop on the lateral and subsurface surfaces. [5] Dorsal tumours are rare, but when they do arise, they are often found more posteriorly

and in close proximity to the midline. [6] Tongue tumours that are oral often stay in the tongue. The floor of the mouth is invaded by tumours in the front part of the oral tongue. [7] Lesions in the middle-thirds penetrate the tongue's musculature and subsequently the mouth's lateral floor. [8] The mandible, the glossotonsillar sulcus, the base of the tongue, the floor of the mouth, the anterior tonsillar pillar, and the posterior portion of the tongue are all affected by carcinomas. [9] Deep infiltration is the typical method of tumour dissemination in tongue base carcinoma, which is a clinically quiet location. During a clinical examination, the size of these tumours is typically underestimated. With the exception of lesions positioned laterally or in late instances, tongue-base tumours often stay in the tongue. In certain cases, the tonsillar fossa may be affected by tongue-base tumours. On the other hand, tonsillar carcinomas often spread to the base of the tongue. The jugulodigastric nodes are the initial echelon nodes for tongue base cancer, and they are followed by the mid and lower jugular nodes. Sometimes retropharyngeal nodes are affected. Anterior tumour extension may indicate involvement of the submandibular nodes. Seldom are submental nodes implicated. At the time of presentation, 75% of patients had positive nodes, and 30% had bilateral nodal metastases.

Occult metastases affect patients with clinically N0 necks at a rate of 30% to 50%. MRI offers useful information from both inside and outside of the tongue. The gross tumour boundary observed during surgery is often misleading, as tongue carcinomas can spread much beyond it. The resection margin is recognised to be the primary factor influencing local recurrence. [10] For most squamous cell carcinomas, 1 cm is thought to be sufficient; however, for tongue cancer, the margins should be 1.5–2.0 cm. [11] Deeply margined tumours are frequently challenging to evaluate during surgery. Furthermore, resecting these tumours is technically more challenging. Therefore, positive or insufficient resection margins are often found at deep margins. Upon presentation, nodal metastases are found in up to 35% of patients. [12]

Five percent of these individuals had involvement in both lymph nodes. [13] The jugulodigastric and submandibular nodes are the first echelon nodes. [14] Submental node involvement is rare, with the exception of individuals who have tongue-tip tumours. [15]

It should be mentioned that the total occult metastatic rate in patients with clinically N0 necks is about 30%. [16]

Numerous clinical investigations have been conducted to establish a relationship between the probability of cervical nodal metastasis and the degree of tumour invasion. These data show that the depth of tumour invasion is the single most significant factor in predicting the metastasis of lymph nodes. [17]

Aims and Objectives

1. To compare the results of histopathology and MRI.
2. To assess the use of MRI in the staging of locoregional TNM (Tumour Node Metastases).
3. To determine the extent of tongue cancer invasion.
4. To compare MRI maximum depth of invasion with histopathology in oral tongue squamous cell carcinoma patients.
5. To compare recorded nodal status between MRI and histopathology.
6. To correlate MRI findings with surgical and anatomical pathological findings wherever possible.

Materials & Methods

This study was a prospective hospital-based investigation that involved 50 patients who had been diagnosed with tongue carcinoma based on clinical or biopsy findings. The patients were referred for magnetic resonance imaging from Acharya Harihara Postgraduate Institute of Cancer to the Department of Radiodiagnosis at SCB Medical College and Hospital, Cuttack, Odisha, for a two-year period. The study was approved by the institutional ethics committee, and the participants provided written informed consent.

Inclusion Criteria

- Clinically diagnosed or biopsy proven operable carcinoma of the tongue.

Exclusion Criteria

- Non-operable tongue cancer.
- Patients with other oral cavity cancers.
- Post radiation/chemotherapy tongue cancer.
- Patients not giving consent for an MRI evaluation.
- Patient not fit for MRI study [cardiac pacemaker/metallic implants/claustrophobia].

Before performing the MRI examination, a detailed history of the patient was taken using the study proforma and a thorough examination of the oral cavity, neck and general systemic examinations was performed.

Statistical Methods

Data was entered in MS Excel and analysed using SPSS software. Results were presented as tables.

Results

Table 1: Demographic Distribution

Age Group (in years)	Number of Patients	Percentage
≤20	0	0%
21-30	2	4%
31-40	9	18%
41-50	15	30%
51-60	14	28%
>60	10	20%
Total	50	100%
Age Distribution		
Sex	**Number of Patients**	**Percentage**
Male	39	78%
Female	11	22%
Total	50	100%
Sex Distribution		

30% of the patients belong to the age group 41–50 years, which was the maximum, followed by the age group 51–60 years, comprising 28% of the patients.

The incidence of tongue cancer is higher in males, constituting 78%, as compared to females, which constitute 22%.

Table 2: Lesion Characteristics (Histopathology)

Laterality	Right	24	48%
	Left	26	52%
Histological grading	G1	44	88%
	G2	4	8%
	G3	2	4%
LVSI (Lymphovascular Invasion)	Present	14	28%
	Absent	36	72%
WPOI (Worst Pattern of Invasion)	Present	12	24%
	Absent	38	76%
Perineural invasion	Present	12	24%
	Absent	38	76%
Both lymphovascular and perineural invasion	Present	6	12%
	Absent	44	88%

Out of fifty cases, 44 (88%) were found to be well differentiated (G1), 4 (8%) moderately differentiated (G2) and 2 (4%) poorly differentiated (G3) squamous cell carcinoma. Lymphovascular invasion was seen in 14 (28%) cases, perineural invasions were seen in 12 (24%) cases. Both lymphovascular and perineural invasions were found in 6 (12%) cases in the post-surgical histopathological study. The worst pattern of invasion was seen in 12 (24%) patients on histopathology.

Table 3

MRI "T" Staging	HPE "T" Staging				Total
	T1	T2	T3	T4	
T1	10	0	0	0	10
T2	0	26	0	0	26
T3	0	4	8	0	12
T4	0	0	0	2	2
Total	10	30	8	2	50
Number of observed agreements: 46 (92.00% of the observations) Number of agreements expected by chance: 19.6 (39.20% of the observations) Kappa= 0.868, Weighted Kappa= 0.895 SE of kappa = 0.063 95% confidence interval: (0.745 to 0.992) Chi-square: 128.889, df: 9, p value: <0.001					
MRI and Histological Tumour (t) Staging Correlation					
MRI N staging	**HPE "N" Staging**				**Total**
	N0	**N1**	**N2**	**N3**	

N0	30	2	0	0	32
N1	0	10	0	0	10
N2	0	0	4	0	4
N3	0	0	0	4	4
Total	30	12	4	4	50
Number of observed agreements: 48 (96.00% of the observations) Number of agreements expected by chance: 22.2 (44.48% of the observations) Kappa= 0.928, Weighted Kappa= 0.955 SE of kappa = 0.050 95% confidence interval: (0.829 to 1.000) Chi-square: 139.062, df: 9, p value: <0.001					
Correlation between MRI and Histopathological N Staging					

The most common site of tongue cancer is the lateral border. Out of 50 cases, 26 (52%) tumours were found on the right lateral border and 24 (48%) on the left lateral border.

For the T stage, there was nearly complete agreement (k = 0.868) between the assessments of histopathology staging and MRI.

Using the chi-square test and kappa statistics, the results demonstrate that there was substantial or almost complete agreement between the histological staging evaluation and the MRI, with p and k values coming out to be < 0.001 and 0.868.

Almost perfect agreement (k = 0.928) was seen between MRI and histopathological N staging assessment.

By applying the chi-square test and kappa statistics, p and k values come out to be <0.001 and 0.928, which shows almost perfect agreement between the MRI and histopathological staging assessment.

Table 4: Sensitivity and Specificity of Radiological Depth in Comparison to Pathological Depth

Radiological Depth (mm)	Pathological Depth (mm)		Total
	<5mm	>5mm	
<5mm	7	1	8
>5mm	1	41	42
Total	8	42	50
Sensitivity= 87.50% (47.35% to 99.68%) Specificity= 97.62% (87.43% to 99.94%) PPV= 87.50% (49.79% to 98.02%) NPV= 97.62% (86.76% to 99.61%) Accuracy= 96.00% (86.29% to 99.51%) Kappa =0.851, 95% CI (0.650-0.100) Chi-square: 36.226, df: 1, p value: <0.001			

MRI and histology both found that the average depth of invasion was 8.664 mm and 7.848 mm, respectively. There was good agreement (k=0.851) between the pathological and radiological tumour depths.

Table 5: Percentage of Cases where the Depth of Tumour Penetration Indicates the Presence of Cervical Malignant Metastatic Lymph Nodes

	Mean (in mm)	Standard deviation	N
MRI	8.664	3.328	50
Histopathology	7.848	3.221	50
Comparison between Histology and MRI for the Depth of Tumour Invasion			
Depth of Tumour (Range)	**No. of Cases**	**Positive Lymph Node**	**Percentage**
≤5mm	8	2	25%
>5mm	42	18	42%
Total	50	20	40%

Cut-Off Values for MRI Depth and Histopathological (HP) Depth

In our study, we observed that a histopathological depth cutoff of 4.3 mm might be used to identify nodal metastasis. The cut-off value for T1wGdMRI depth was 4.9 mm. Groups were subdivided into those ≤5mm and >5mm in comparison to the standard HP depth of 5mm. For each group, the nodal metastasis rates were 42% and 25%, respectively.

Discussion

OSCC (Oral Squamous Cell Carcinoma) is the sixth most prevalent cancer worldwide and one of

the oral cancers that is increasing the fastest, according to oncology literature. In South Asian nations, particularly India and Sri Lanka, it is increasingly prevalent. Oral cancers are mostly caused by tobacco use and severe alcohol consumption. 90% of all oral malignancies are caused by tobacco use alone. The majority of occurrences of oral cancer occur in people between the ages of four and six. The chance of having mouth cancer rises with age. According to the current study, the mean age of OTSCC patients was 50.16 years, and the age group most frequently involved was 41–50 years old (30%), followed by 51–60 years old (28%).

Appropriate therapy planning requires accurate preoperative staging. Early tongue tumours are often localised within the tongue. Advanced tumours have the potential to spread to nearby structures, including the mandible, anterior tonsillar pillar, floor of the mouth, and base of the tongue.

The AJCC staging manual, eighth edition, included new staging criteria for the "T" stage of oral cancer, [18] including histological depth of invasion cutoff values of ≤5mm, >5mm but ≤10 mm, and >10 mm. Therefore, even millimetre mistakes in the depth of invasion might alter the OTSCC staging.

In our study, 50 patients with tongue cancer (39 men and 11 women) had appropriate pre-operative radiographic measurements of the tumor's depth of invasion and staging. After glossectomy, the tumor's depth of invasion was evaluated histologically. When it comes to local recurrence, disease-free patient survival, and subclinical nodal metastases, depth of invasion is a more reliable predictor. Thus, precise preoperative evaluation of the level of invasion is crucial for organising the therapeutic treatment of tongue cancer.

The assessment of tongue cancer can also be done using ultrasonography; [19,20] However, there are certain challenges associated with this type of evaluation. These include the inability to see superficial lesions, decreased precision in determining the extent of large tumours, extreme patient discomfort that makes it difficult to place the probe accurately, and interpretation that is more operator-dependent.

According to our research, there is fair to high agreement (kappa value 0.868) between histological assessments and MRI results for T staging. T3 staging MRI over an estimated four analysis had the same final staging as determined by MR imaging. These findings are in line with research by Tetsumura et al. [21] in which the tumour breadth and depth were evaluated using both MR and HPE images, and the authors found a strong connection between the values obtained from the two methods.

The literature shows that tumour thickness and invasion depth are the most reliable indicators of cervical nodal metastasis out of all the prognostic factors that have been studied. Although many writers use these two words interchangeably, Moore et al. pointed out that depth of invasion and tumour thickness are not the same and that differentiation must be established. The term "depth of invasion" refers to how far a malignancy has spread into the tissue that lies underneath an epithelial surface. Clinical evaluation of tumour thickness (depth of invasion) is not possible. Imaging plays a major part in determining the depth of tumour invasion. Our study showed a mean radiological tumour thickness of 8.664 (standard deviation 3.328) mm and a histological tumour thickness of 7.848 mm (standard deviation 3.221). Invasion depth in MRI and histological samples correlated significantly in our study (accuracy = 96.00%, kappa = 0.851, specificity = 97.62%, sensitivity = 87.50%). This result is in line with research conducted by Preda et al., who examined 33 oral tongue SCC cases in a retrospective series. [22] The association between MRI thicknesses and histological tumour thicknesses was shown to be strong by the authors (correlation coefficient = 0.68, $P < 0.0001$). Of the 114 patients with oral cavity and oropharyngeal SCC that Park et al. [23] investigated, 46 had oral tongue SCC. A strong connection ($r = 0.949$) was seen between MRI and the histologic depth of invasion in the oral tongue subsite.

This result is also in line with research by Weing Tang et al. [24] and Reddy Ravikanth, [25] which discovered that radiological and pathological tumour depth showed good agreement ($k = 0.844$). The Pearson's correlation coefficient between HP depth and T1WGd MRI depth was 0.851 ($p < 0.001$), indicating a strong correlation between HP depth and T1WGd MRI depth.

In the current study, MRI revealed a somewhat higher depth of invasion in relation to histological thickness. Though the specimen was immediately stretched and pinned on a foam board, the specimen may have shrunk during formalin fixation, which might account for the disparity between the histologic and radiologic depth of invasion. It has been observed that the oral cavity tissues shrank somewhere between 14.9 and 23.9%. [26] This might be the reason why MRIs are over staging.

For head and neck tumour patients, the prognosis and course of therapy depend greatly on the identification of cervical node metastases. Up till now, form, size, extracapsular distribution, and an aberrant interior architecture have been the factors utilised by traditional imaging methods. While central necrosis is the most accurate indicator of

malignancy, size is undoubtedly the most commonly used diagnostic criteria. [27]

Based on the radiological depth of invasion computed from contrast-enhanced T1-weighted images, lymph nodal metastasis was predicted and subsequently compared with the histopathological nodal status. The lymph nodal metastasis was divided according to two groups: those ≤5mm and >5mm, in comparison to the standard HP depth of 5mm. Only 20 patients out of 50 showed metastasis to the cervical lymph nodes, according to the depth of the invasion. A total of eight cases showed a depth of invasion ≤5 mm, out of which two patients (25%) showed metastatic cervical lymphadenopathy; 42 cases showed a depth of invasion >5mm, out of which 18 patients (42%) were positive for metastasis.

Similar agreement between this result and Reddy Ravikanth's study is evident. According to him, a tumour with a depth of invasion up to 5mm has 24% nodal metastasis, while a tumour with a depth of invasion of more than 5mm has 52% nodal metastasis. Our study shows almost perfect agreement (k = 0.928) and a 95% CI (0.829 to 1.000) for the N atage between MRI and histopathology staging assessment.

Similar investigations were carried out by Zeng et al., who discovered that MRI performed well in exhibiting tumour invasion, invasion depth, and invasion extension. Another research by Paul Lam et al. 50 compared the histology tumour thickness with the radiological tumour thickness on contrast-enhanced T1-weighted and T2-weighted images. They came to the conclusion that MR scans offer adequate precision for determining the thickness of tumours and determining the stage of tongue cancer. This is in line with the findings of our current investigation, which likewise demonstrates good or substantial agreement (kappa value 0.868) between pathological staging evaluations and MRI for T staging.

Conclusion

MRI is the preferred imaging modality for the assessment of tongue carcinoma due to its ability to precisely stage the tumour using the TNM classification system. This staging is essential for optimising treatment choices, such as glossectomy/marginal mandibulectomy, radiation, or both.

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