

Accuracy of MRI for Assessment of Depth of Invasion and Cervical Lymph Node Metastasis in Tongue Carcinoma

Sharmin S.¹, Bhowmik B.², Ali M.N.³, Banu M.L.A.⁴, Habib M.⁵

Abstract

Background: Tongue carcinoma is one of the most aggressive malignancies of the oral cavity. Magnetic resonance imaging (MRI) is a very important and useful imaging modality to diagnose tongue carcinoma. In the latest, 8th edition of UICC cancer staging manual was modified by incorporating depth of invasion (DOI) in the T categorization of oral cavity cancer. Tongue carcinoma has a relatively unfavourable prognosis. And that is possibly due to the absence of a strong barrier to prevent tumor diffusion and the presence of a well developed lympho-vascular system that increases the risk of metastasis.

Objective: To evaluate the accuracy of MRI in the assessment of depth of invasion and cervical lymph node metastasis in tongue carcinoma.

Methodology: This cross-sectional study was conducted at the Department of Radiology and Imaging at BSMMU, Dhaka, from March 2021 to February 2023. A total of 30 patients with tongue carcinoma were enrolled after informed written consent. All patients were subjected to detailed history and thorough clinical examination along with magnetic resonance imaging and histopathological examination.

Results: Mean age of the study patients was 51.83 ± 8.13 (SD) years with male predominance (70% male and 30% female). Majority of the patients presented with painless non healing ulcer (50%) and lymphnode involvement occurred in 46.7% patients. In MRI it was found that 40% patients had stage T2 cancer and histopathologically it was found that, 90% had squamous cell carcinoma. The mean depth of tumor invasion was 10.16 ± 5.07 mm in MRI, and 9.37 ± 3.68 mm in histopathological examination. Taking cut-off value of depth of invasion < 5 mm, MRI showed sensitivity, specificity, PPV, NPV and accuracy of 85.7%, 91.3%, 75%, 95.5% and 90% respectively to correctly diagnose tongue carcinoma. There was a strong positive correlation between MRI and histopathological depth of invasion, that is MRI depth correlated well with the histopathological depth of tumor invasion ($r=0.819$). In our study, sensitivity, specificity, accuracy, positive predictive value and negative predictive value of MRI in determining cervical lymph node metastasis were 92.8%, 93.7%, 93.3%, 92.8 % and 93.7%.

Conclusion: MRI is the modality of choice in diagnosing tongue carcinoma and cervical lymph node metastasis with high sensitivity and specificity considering histopathology as gold standard.

Keywords: Tongue carcinoma, MRI, Depth of invasion, cervical lymph node metastasis

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1. **Shohaila Sharmin**, Medical Officer, Dept. of Radiology & Imaging, National Institute of Neurosciences & Hospital, Dhaka.
2. **Prof. Dr. Bishwajit Bhowmik**, Professor, Dept. of Radiology & Imaging, BSMMU.

Corresponding Author

Dr. Shohaila Sharmin, Medical Officer, Medical Officer, Dept. of Radiology & Imaging, National Institute of Neurosciences & Hospital, Dhaka. Sher-E- Bangla Nagar, Dhaka, Bangladesh.

Phone: +8801711601658, **E-mail:** shohailasharmin@gmail.com.

3. **Mir Nowazesh Ali**, Associate Professor, Department of Oral and Maxillofacial Surgery, BSMMU
4. **Mst. Laila Akter Banu**, Associate Professor, Conservative Dentistry and Endodontics, Dhaka Dental College
5. **Muntasir Habib**, Medical Officer, Dept. of Urology, SSMCMH

Introduction

Tongue carcinoma is one of the most aggressive malignancies of the oral cavity. The incidence of tongue carcinoma varies globally and it is more common in southeast Asia.¹ Tongue remains the most common intraoral site for oral cancer worldwide with reported incidence of 17.8-52% and the second commonest cancer of oral cavity in India.² Bangladesh has also a high incidence of oral cancer. In this country, the number of new cancer cases is about 200000 per year, of which oral cancer presents 20% and it is the third leading cancer in this country. Here, the buccal mucosa, retromolar trigone, tongue and floor of the mouth are the most frequent sites and this is due to widespread chewing of betel quid or pan and smoking habits.³

Tongue carcinoma has a relatively unfavourable prognosis. And that is possibly due to the absence of a strong barrier to prevent tumor diffusion and the presence of a well developed lympho-vascular system that increases the risk of metastasis. As the oral cavity is easily accessible tongue carcinoma is easily identified and diagnosed by taking a biopsy. Surgery is the primary treatment strategy for tongue carcinoma. So, after pathological confirmation, imaging is essential for adequate tumor staging.⁴ The Union for International Cancer Control's (UICC) TNM classification is the internationally accepted standard for cancer staging where, T describes the size of the tumor, N describes the regional lymph node status and M describes the presence of distant metastasis. In the latest, 8th edition of UICC cancer staging manual was modified by incorporating depth of invasion (DOI) in the T categorization of oral cavity cancer.⁵ DOI refers to the extent of tumor beneath an epithelial surface and it predicts the risk of lymphatics and haematogenous spread more accurately.⁶ Because DOI is strongly associated with cervical lymph nodes metastasis which is most important negative prognostic factor of oral cavity cancer.⁷ MRI is the preferred imaging modality compared to computed tomography as it provides better soft tissue visualization in tongue cancer.⁵

MRI has become the cornerstone for pretreatment evaluation of carcinoma tongue and provided accurate information regarding the extent of the lesion and

depth of invasion that helps the clinician to optimize treatment strategy.⁸ MRI can provide excellent quality images and direct multiplanar formats without ionizing radiation. Early cancer can be treated with either surgery or radiotherapy. While, advanced cancers are offered precise extent of resection and indicate whether organ conservation therapy should be offered. Quality of life issues necessitate preservation of form and function. So the pretreatment imaging helps plan appropriate reconstruction and counsel patients regarding life style changes.⁹ MRI findings and P-DOI are important when assessing the need for elective neck dissection, as the national comprehensive cancer network (NCCN) recommends elective neck dissection in case of DOI greater than 4 mm.⁷

We hypothesized that MRI can accurately measure the depth of invasion in tongue carcinoma. So, this study was conducted prospectively to evaluate the accuracy of MRI for assessing the depth of invasion of tongue carcinoma with histopathological correlation. In our country maximum people live below the standard level of economical parameter. So, without a clear and rational strategy, the inappropriate use of imaging may increase cost, inappropriate & delayed diagnosis, psychological burden, physical stress and treatment delay. As cancer patient has to undergo surgery, proper prior TNM staging is mandatory for accurate treatment planning to minimize cost and sufferings. MRI is the perfect imaging modality and more beneficial compared to other imaging modalities in TNM staging of tongue carcinoma, as well as the assessment of the depth of invasion which greatly affects occult node metastases.

There has been a paucity of studies on this topic from Bangladesh, where oral carcinoma is one of the leading one. The result of the study may guide clinicians to find out high risk patients, and help the patients in guiding them for proper diagnosis and treatment.

Methodology of the Study

This cross-sectional study was carried out from March 2021 to February 2023 in the Department of Radiology and Imaging, Department of Oral & Maxillofacial Surgery and Department of Pathology, in Bangabandhu

Sheikh Mujib Medical University (BSMMU). Patients with tongue carcinoma, irrespective of age and sex after fulfilling the inclusion and exclusion criteria was the sample of study. Purposive sampling was done. After formal ethical clearance from IRB of Bangabandhu Sheikh Mujib Medical University (BSMMU), a total of 30 patients fulfilling inclusion and exclusion criterion who were referred to the Department of Radiology & Imaging for MRI of Tongue from the Department of Oral & Maxillofacial Surgery of BSMMU were included. All the study participants were subjected to magnetic resonance imaging and after surgical treatment were followed to collect the histopathological examination reports. MRI examinations were performed with Siemens MAGNETOM Skyra 3.0 Tesla MRI System using head and neck coil. From base of the skull to root of the neck region was imaged in three standard planes i.e. coronal, axial & sagittal planes using T1W, T2W, DWI, ADC & T1W post contrast sequences. The patient was placed in supine position during the examination. Abnormal signal intensity if present in T1W, T2W, and/or STIR images were recorded. Actual tumor size based on T2W, STIR, DWI with surrounding structure invasion and identification of enlarged lymph nodes were taken

into consideration. Second, the post contrast coronal images were analyzed to measure the depth of invasion at a picture archiving and communication system workstation. Pre-operative TNM staging was based on size of the primary tumour with following criterion. T1: Size ≤ 2 cm and DOI ≤ 5 mm; T2: Size ≤ 2 cm and DOI 5-10 mm or Size 2-4 cm and DOI ≤ 10 mm; T3: Size > 4 cm and DOI > 10 mm where DOI stands for depth of invasion. To see strength and nature of relationship or correlation between our two variables (MRI DOI and histopathological DOI), Pearson's correlation coefficient test was done, where 'r': [value range from -1 to +1] was taken, Where positivity indicated direct or positive relation.

Considering histopathological diagnosis as the gold standard, the MRI diagnosis was compared with histopathological reports to assess the accuracy of MRI in the assessment of depth of invasion and cervical lymph node metastasis in tongue carcinoma.

Results

A total 30 patients with carcinoma of tongue presenting with signs and symptoms were included in this study.

Table-I: Age distribution of the study participants (n=30).

Age in years	Frequency (n)	Percentage (%)
18-30	01	3.3
31-40	02	6.7
41-50	04	13.3
51-60	20	66.7
61-68	03	10
Mean $\pm$ SD	51.83 $\pm$ 8.13	
Range (min-max)	18-68	

Table-I demonstrates that the mean age of the study participants was 51.83 $\pm$ 8.13 years of age, minimum age was 18 years and maximum age was 68 years. Majority of the participants belonged to 51-60 age group (66.7%), followed by 41-50 age group (13.3%), 61-68 age group (10%), 31-40 age group (6.7%), and 18-30 age group (3.3%).

In the current study, male predominance was observed 21(70%) compared to female 09(30%).

Table-II: Clinical presentation of the tongue carcinoma patients (n=30)

Variable	Frequency (n)	Percentage (%)
Ulcer in tongue	09	30
Painless non healing growth	15	50
Difficulty in swallowing	05	16.7
Pain in tongue	14	46.7
Cervical lymph node enlargement	05	16.7
(Unilateral-Bilateral)	(3-2)	(10%-6.7%)
Increased salivation	02	6.7

Table-II shows that majority of the patients presented with painless non healing ulcer (50%), followed by pain in tongue (46.7%), ulcer in tongue (30%), difficulty in swallowing (16.7%), cervical lymph node enlargement (16.7%) (among them 10% unilateral and 6.7% bilateral involvement) and increased salivation (6.7%).

Table-III: Site of lesion in MRI in tongue carcinoma patients (n=30)

Variable	Frequency (n)	Percentage (%)
Dorsal surface	02	6.7
Ventral surface	04	13.3
Lateral border	22	73.3
Base	01	3.3
Tip	01	3.3

Table-III shows that the most affected side of tongue carcinoma was lateral border of the tongue (73.3%), followed by ventral surface (13.3%), dorsal surface (6.7%), base (3.3%) and tip of the tongue (3.3%).

Table-IV: Extension of lesion in MRI findings in the study participants (n=30)

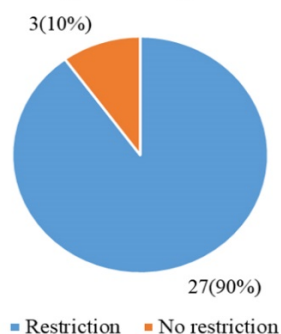
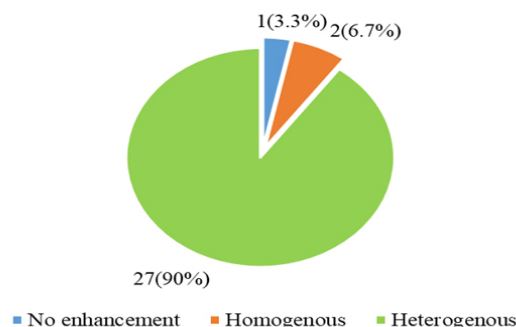
Variable	Frequency (n)	Percentage (%)
Confined to tongue	12	40
Perilesional fat	10	33.3
Surrounding structure	7	23.3
Bony involvement	1	3.3

Table-IV shows that in 40% patient the lesion was confined to the tongue, 33.3% involved the perilesional fat, 23.3% was found to invade the surrounding structures and 3.3% involved the bones.

Table-V: MRI appearance in T1WI, T2WI, STIR and DWI image (n=30)

MRI appearance	T1WI n(%)	T2WI n(%)	STIR n(%)	DWI n(%)
Hyperintense	1(3.3)	27(90)	27(90)	27(90)
Isointense	27(90)	03(10)	03(10)	03(10)
Hypointense	02(6.7)	0(0)	0(0)	0(0)

Table-V summarizes the findings of MRI, where T1 weighted image showed isointensity in 90%, hypointensity in 6.7% and hyperintensity in 3.3% images. In T2 weighted image signal was hyperintense in 90% and isointense in 10% and in STIR signals were hyperintense in 90% and isointense in 10% cases. In DWI there was hyperintense (90%) and isointense (10%) signals.

Diffusion weighted image with ADC map**Fig-1:** shows DW image with ADC map in the study subjects. (n=30)**Post Gadolinium study****Fig-2 :** shows post gadolinium study in the study participants (n=30)

In diffusion weighted image (Fig:1) with ADC map, most of the lesions (90%) showed restriction in the image and 10% showed no restriction in image. In post gadolinium study, (Fig:2) 90% images showed heterogenous enhancement, 6.7% showed homogenous enhancement. However, in 3.3% cases no enhancement was observed.

Table-VI: Lymphnode involvement in the study participants (n=30)

Variable	Frequency (n)	Percentage (%)
Enlarged lymphnodes	14	46.7
Unilateral	08	26.66
Bilateral	06	20
No enlarged lymphnode	16	53.3

Table-VI shows that in the current study, lymphnode involvement occurred in 14(46.7%) participants. Among them 26.66% had unilateral and 20% had bilateral involvement.

Table-VII: MRI T-staging of tongue carcinoma in the study participants (n=30)

Variable	Frequency (n)	Percentage (%)
T1	08	26.7
T2	12	40
T3	10	33.3

Table-VII demonstrated that in MRI 26.7% participants had stage T1, 40% had T2 and rest 33.3% had T3 carcinoma.

Table-VIII: Histopathological diagnosis of tongue carcinoma in the study participants (n=30)

Variable	Frequency (n)	Percentage (%)
Types of carcinoma		
Squamous cell carcinoma	27	90
Others (Mucoepidermoid carcinoma)	03	10
Grade of lesion		
High grade	17	56.7
Low grade	13	43.3

Table –VIII showed the results of histopathological examination, where 90% had squamous cell carcinoma and 10% had other type of carcinoma (Mucoepidermoid carcinoma). 56.7% had high grade carcinoma and 43.3% had low grade. High grade are undifferentiated and poorly differentiated carcinoma. Low grade are well-differentiated and moderately differentiated carcinoma.

Table-IX: MRI and histopathological depth of invasion measurement (n=30)

Variable	Mean (mm)	SD
MRI	10.16	5.07
	Range (min-max) 3-22	
Histopathology	9.37	3.68
	Range (min-max) 3-22	

The mean depth of tumor invasion was 10.16 ± 5.07 mm in MRI, and 9.37 ± 3.68 mm in histopathological examination as depicted in Table-IX.

Table-X: Comparison between histopathology and MRI to assess the depth of invasion of tongue carcinoma (n=30)

MRI depth (mm)	Histopathological depth (mm)		Total	p-value
	<5	≥5		
<5	06 (TP)	02 (FP)	8	<0.001*
≥5	01 (FN)	21(TN)	22	
Total	7	23	30	

p-value obtained by Chi-square test, *significant

Table-X shows the McNemar's chi-square test for the 2x2 contingency table to analyze the data. P value was <0.001. Hence, the result was statistically significant. A cut-off value of depth of invasion was taken to be <5 mm. TP stands for true positive, FP for false positive, FN for false negative and TN for true negative cases.

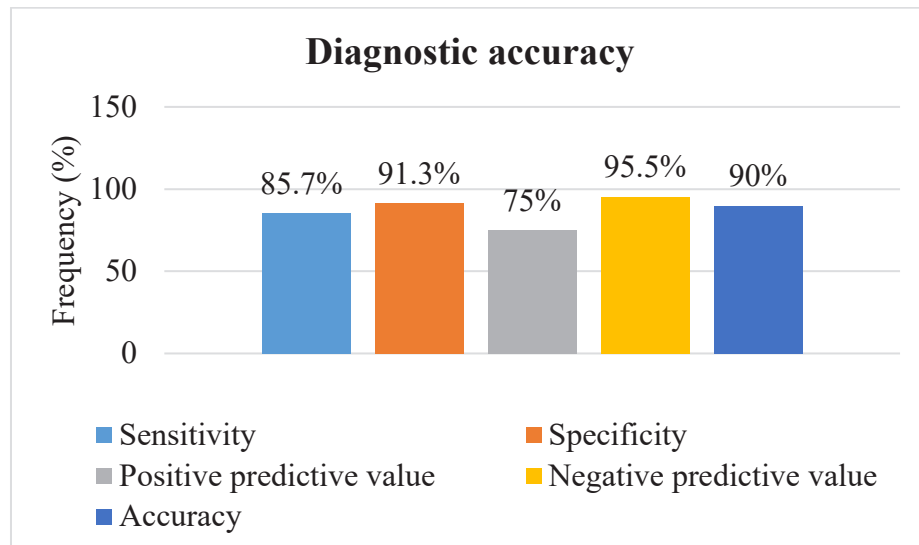


Fig-3: Accuracy of depth of invasion in the tongue carcinoma patients (n=30)

In fig-3, the bar diagram shows that MRI has sensitivity, specificity, PPV, NPV and accuracy of 85.7%, 91.3%, 75%, 95.5% and 90% respectively in the assessment of the depth of invasion of Tongue Carcinoma taken into account histopathology as a gold standard.

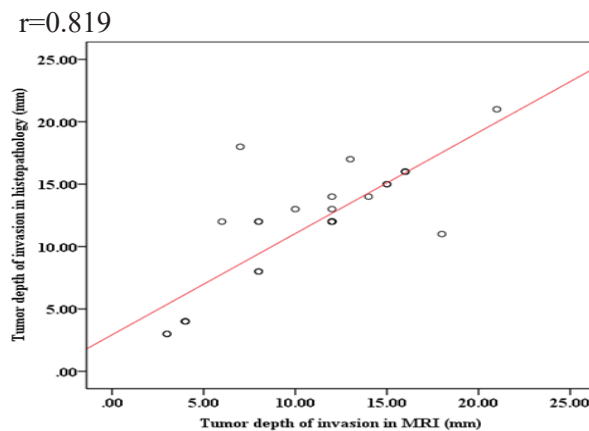


Fig-4: Correlation of MRI and histopathological depth of invasion of tumor (n=30).

Fig-4 showed that there is a strong positive correlation between MRI and histopathological depth of invasion, that is MRI depth correlated with the histopathological depth of tumor invasion. ($r=0.819$)

Table - XI: Comparison between histopathology and MRI for the assessment of lymph node metastasis in tongue carcinoma.

MRI Lymph node metastasis	Histopathological diagnosis	
	lymph node metastasis	
	Present	Absent
	(n=14)	(n=16)
Present (n=14)	13(TP)	01(FP)
Absent (n= 16)	01(FN)	15(TN)
Total	06	24

Table-XI shows MRI diagnosis for cervical lymph node metastasis out of 30 cases, true positive 13 cases, 1 case false positive, 1 case false negative and 15 cases true negative. Sensitivity, specificity, accuracy, positive predictive value and negative predictive value of MRI in determining lymph node metastasis were 92.8%, 93.7%, 93.3%, 92.8 % and 93.7%.

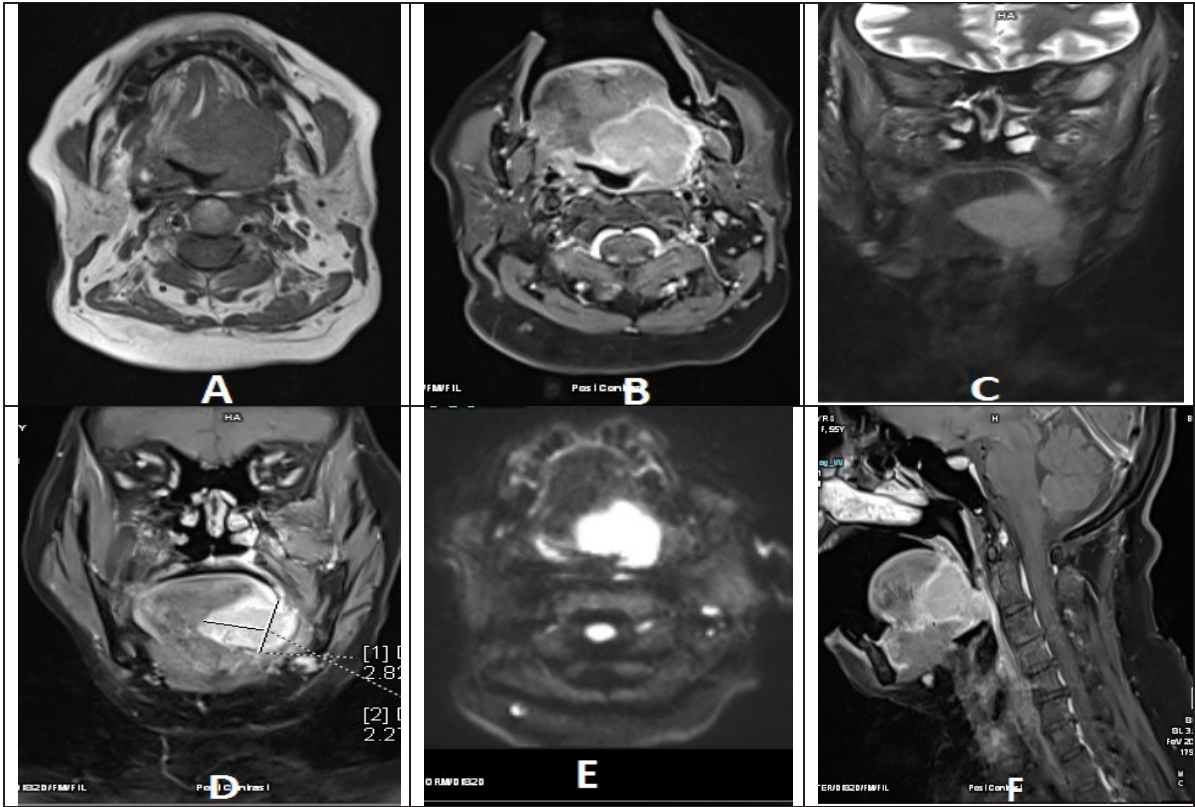


Fig-5: (A) T1 non contrast axial, (B) FS T1 post contrast axial, (C) STIR coronal, (D) FS T1 post contrast coronal, (E) DWI axial, (F), T1 FS post contrast sagittal images showing enhancing mass lesion at base of the tongue. DOI is about 22mm.

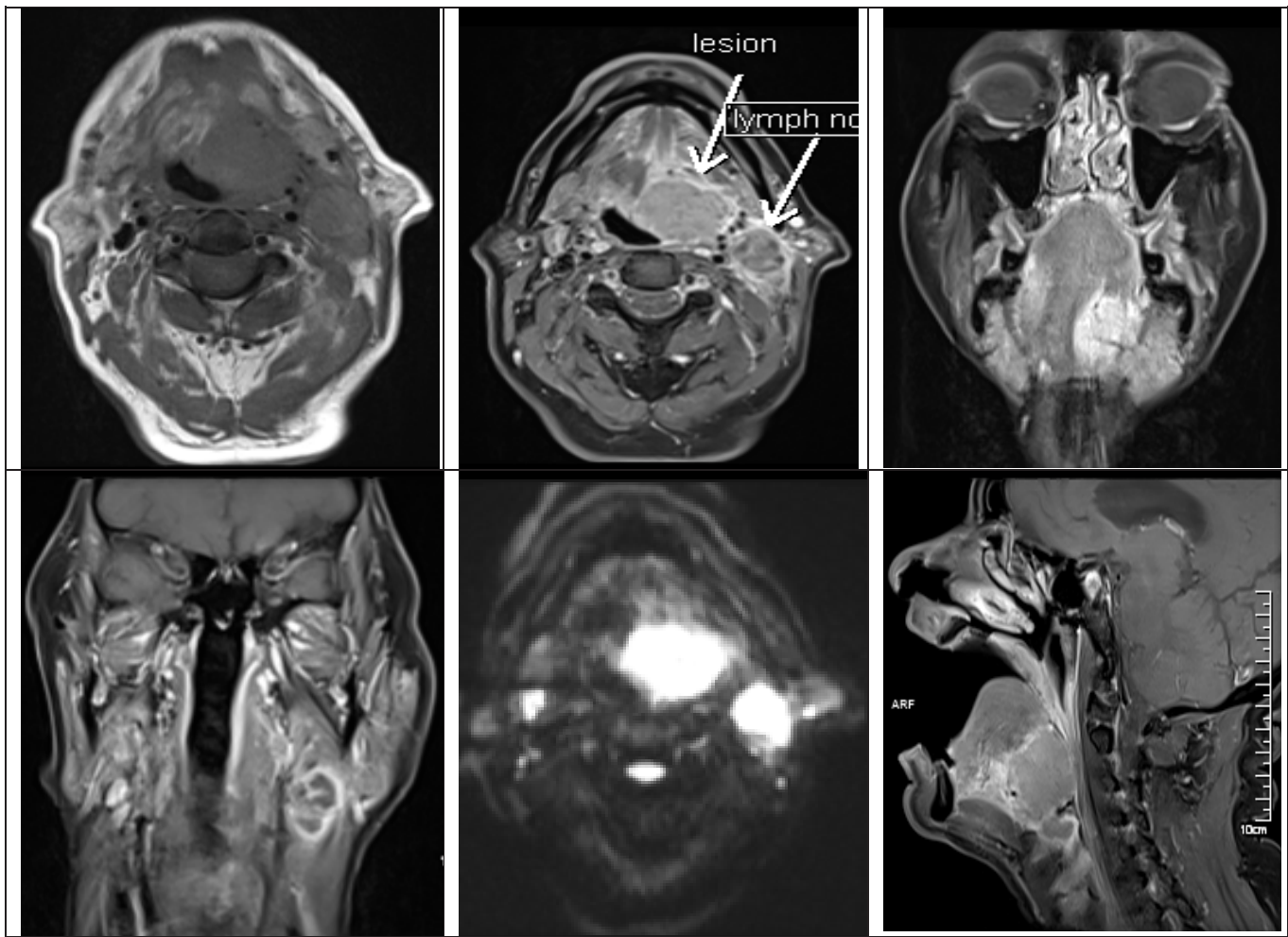


Fig-6: Left upper image (A) showing T1W non contrast axial image, **upper middle image (B)** showing FS T1 post contrast axial image, **right upper and and left lower image (C & D)** showing post contrast coronal images, **Lower middle image (E)** showing DWI axial and **right lower (F)** is FS T1 post contrast sagittal images showing a large enhancing mass lesion at left lateral border extending upto base of the tongue. FS T1 post contrast coronal image (**left lower image**) (D) shows an enlarged lymph node at level II left which also shows restriction on DWI (**Lower middle image**) (E).

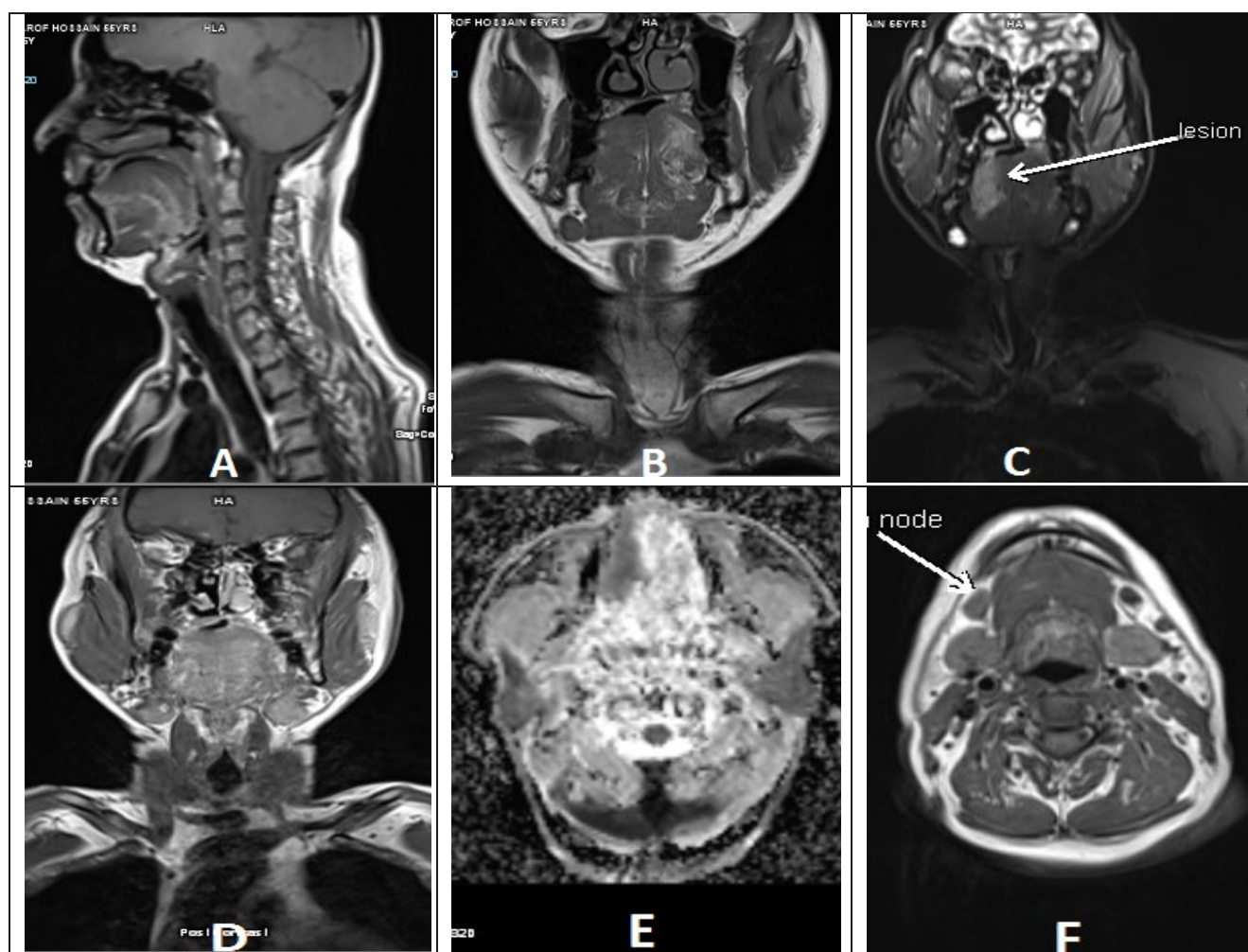


Fig-7: T1 sagittal (A) and coronal (B), STIR coronal (C), FS T1 post contrast coronal (D), ADC (E) images show enhancing lesion at right lateral border of tongue. T1 axial (F) image shows an enlarged lymph node at level 1b right

Discussion

The tongue is the most common intraoral site for cancer in most of the countries.¹⁰ MRI is the imaging modality of choice for evaluation of tongue carcinoma as MRI helps in the accurate staging of the tumor using TNM classification which is crucial for optimizing treatment options.⁸ This study is aimed at evaluation of the accuracy of MRI in the assessment of depth of invasion and cervical lymph node metastasis in tongue carcinoma.

In the current study, there was male predominant with male (70%) and the mean age of the study participants was 51.83 ± 8.13 years of age, ranges from 18 to 68 years. Majority of the participants belongs to 51-60 age group (66.7%), followed by 41-50 age group (13.3%), 61-68 age group (10%), 31-40 age group (6.7%), and 18-30 age group (3.3%). Harada et al., in their study identified the mean age was 53.7 years with range from 26-86 years and male predominance was also found in their study which is in concordance with the current study.¹¹

In our study, majority of the patients presented with painless non healing ulcer (50%), followed by pain in tongue, ulcer in tongue, difficulty in swallowing, cervical lymph node enlargement, and increases salivation in 46.7%, 30%, 16.7%, 16.7%, and 6.7% respectively. Gorsky et al., in their study showed that 66.5% patients had sore tongue, 28.7% had lump in tongue, dysphagia in 17.4% which is in agreement with current study findings.¹² Kamstra et al., in their study identified that 6.7% patients had excessive saliva which is similar to the current study findings.¹³

Tang et al., in their study observed that the most common tumor site was the border of the tongue, accounting for 77.9% of the tumors, followed by ventral and dorsal surfaces, accounting for 19.6% and 2.5% of the tumors, respectively.¹⁴ These findings are similar to this study findings where the most affected side of tongue cancer was lateral border of the tongue (73.3%), followed by ventral surface (13.3%), dorsal surface (6.7%), base (3.3%), and tip of the tongue (3.3%).

In our MRI study, it was found that in majority of the patients lesions were confined to tongue (40%), followed

by perilesional fat (33.3%), surrounding structure (23.3%), and in 3.3% cases there were bony involvement. The mean depth of tumor invasion was 10.16 ± 5.07 mm in MRI and 9.37 ± 3.68 mm in histopathology.

In the current study, lymphnode involvement occurred in 46.7% participants. Rifat et al., in their study identified that frequency of lymph node metastasis was 24(48.0%) in oral carcinoma patients with varying degree of lymph node involvement.¹⁵

MRI findings in this study showed that 26.7% participants had stage T1, 40% had T2 and rest 33.3% had T3 carcinoma. Similarly Park et al., found that according to the primary tumour site T stage was classified as T1 24.6%, T2 was 44.7%, T3 in 22% and T4 in 8.8%.¹⁶ Tang et al., in their study admitted that among oral cancer cases the incidence of tongue squamous cell carcinoma ranks first which was in concordance with our study findings where 90% of the study participants had squamous cell carcinoma.¹⁷

In this study, more than half of the patients (56.7%) had high grade carcinoma and 43.3% had low grade. Akhter et al., in their study documented that 44% of their patients had well differentiated (grade I) carcinoma and other had moderate or poor differentiated carcinoma which is in line with the present study.¹⁸

A strong positive correlation was documented in depth of tumor invasion in MRI and histopathology in this study. Similarly, Huopainen et al., in their study identified a significant correlation in depth of invasion between MRI and histopathology. Ravikanth in his study documented similar findings where he admitted that Pearson's correlation coefficient of histopathological depth and MRI depth suggesting that histopathological depth shows a strong correlation with MRI depth ($r=0.851$).⁸

Conclusion

It can be concluded that MRI showed a strong correlation with histopathological findings in the assessment of depth of invasion and cervical lymph node metastasis in tongue carcinoma, making MRI the choice of modality for staging of tongue carcinoma.

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