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MAGNETIC RESONANCE IMAGING IN EVALUATION OF MALIGNANCIES OF TONGUE AND ORAL CAVITY

Radio-Diagnosis

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ABSTRACT

INTRODUCTION: In recent times, Diffusion weighted MRI(DW-MRI) in conjunction with anatomical MRI has emerged as the leading modality of choice to characterize and stage these malignancies, as recent studies have shown it to be superior in detecting nodal metastasis. What makes DW-MRI popular is the non-invasive acquisition, it does not require any exogenous contrast agents and no ionizing radiation. It is quantitative and can be obtained relatively rapidly.

AIM : To evaluate the malignancies of tongue and oral cavity with the help of different sequences of magnetic resonance imaging (MRI).

MATERIAL AND METHODS: This is a cross-sectional observational study conducted in the Department of Radiodiagnosis, GMCH, Udaipur during the period January 2020 to July 2021. All patients clinically suspected to have malignant tongue and oral cavity lesions along with treatment naïve patients with diagnosed malignancies were included irrespective of age and sex were included.

RESULTS: Out of 56 patients, 51.8% had carcinoma buccal mucosa, 26.8% had carcinoma tongue, 12.5% had carcinoma alveolus, 5.4% had carcinoma gingivobuccal sulcus and 3.6% had carcinoma lip. The cut-off value of 1.15 x10^{-3} mm^2/s for ADC on ROC analysis. For diagnosing metastatic lymph nodes, the AUC was found to be 0.88 ± 0.04, p value < 0.001.

CONCLUSION: MRI T and overall staging had fair level of agreement with clinical T and staging. MRI T had moderate agreement with histological T, near perfect agreement with N and substantial agreement for overall staging. MRI had a sensitivity of 96.4%, specificity of 89.2% and overall diagnostic accuracy of 92.8% for detecting lymph node metastasis.

KEYWORDS

INTRODUCTION

India has the distinction of having the world's largest number of oral cancer patients with an annual age-standardized incidence of 10.4 per 1,00,000. In India, it is the most common cancer amongst males (16.1% of all cancers) and the fourth commonest cancer amongst females (4.1% of all cancers).[1]

Accurate standardized imaging in oral malignancies is a boon for judging operability and assessing the prognostic characteristics such as the tumour thickness, cervical lymph nodal metastases and extracapsular spread. [2]

In recent times, Diffusion weighted MRI(DW-MRI) in conjunction with anatomical MRI has emerged as the leading modality of choice to characterize and stage these malignancies, as recent studies have shown it to be superior in detecting nodal metastasis. What makes DW-MRI popular is the non-invasive acquisition, it does not require any exogenous contrast agents and no ionizing radiation. It is quantitative and can be obtained relatively rapidly. [2]

The American Joint Committee on Cancer (AJCC), 8th edition gives a fresh direction to the staging of head-and-neck cancers. It introduces several novel considerations into the staging of head-and-neck cancer, with distinct therapeutic ramifications, to stage patients better. Under the new guidelines for oral cavity malignancies, depth of invasion is introduced as a determinant of T-stage. This results in standardization of the staging and highlights the role of depth of invasion in nodal spread and overall survival. [3,4]

DOI is more important in the context of tumour infiltration than the tumour thickness. It is known that the risk of nodal metastasis and recurrence increases with increase in DOI.[5,6]

However, the limitation rises due to challenges in measurement of DOI clinically in certain subsites and interobserver variability.[4]

Thus, the present study evaluated the accuracy of radiological depth of invasion and staging in influencing management regarding surgical access and planned margins along with prediction of cervical metastasis and evaluated the role in ensuring only essential and effective surgical management and neck dissection.

AIM AND OBJECTIVES

- To evaluate the malignancies of tongue and oral cavity with the help of different sequences of magnetic resonance imaging (MRI).

MATERIAL AND METHODS

This is a cross-sectional observational study conducted in the Department of Radiodiagnosis, GMCH, Udaipur during the period January 2020 to July 2021. All patients clinically suspected to have malignant tongue and oral cavity lesions along with treatment naïve patients with diagnosed malignancies were included irrespective of age and sex were included.

Patients who had a contraindication to MRI (such as those with pacemakers, cochlear implants, and claustrophobic patients). Those having any previous history of surgical treatment, radiotherapy, or chemotherapy for malignancy of tongue & oral cavity and patients who had allergic manifestations in previous contrast studies were excluded. We included 56 eligible patients in our study.

A detailed history of the patient was taken including a history of any occupational exposures to carcinogens/toxins, any history of tobacco and smoke exposure (tobacco chewers or smokers), personal health history, and history of malignancy. Each patient was subjected to a detailed clinical examination to establish their clinical TNM stage.

All 56 patients were at or below TNM stage IVa according to and underwent surgery thereafter. The postoperative samples were then sent for histopathological examination and histopathological TNM staging was also described by a pathologist.

MR Technique

All the studies were performed on a 3 Tesla scanner (SIGNA ARCHITECT) The patient was placed in the supine position on the MRI table and a dedicated 16 channel head neck (HNS) coil was applied for both conventional and DW-MRI. The Range was kept from the base of the skull to the clavicles in a matrix of 276 x 184 FOV at 250 with a slice thickness of 3-4mm.

Routine T1WI [Axial and coronal spin-echo T1 W (TR, 500-600ms; TE,7-10ms)], T2WI [Axial, coronal and sagittal fast spin-echo T2 W (TR,3000-4000 ms; TE,90-100ms)], Short Tau Inversion Recovery

(STIR) at inversion time of 150ms sequences in coronal plane, axial diffusion-weighted sequence (at b value of 0.500 and 1000s/mm2 per axis) followed by axial T1W (post-contrast) sequence were performed.

Depth of tumor invasion

The sequence of choice for measurement of the depth of invasion for tongue and buccal subsites was axial gadolinium-enhanced T1-weighted.

The reference line was drawn as a horizontal line tangential to the two tumor–mucosa junctions with a perpendicular line drawn from this line to the point of maximal tumor projection, thereby giving us the depth of invasion.

In the case of ulcerative tumors, the reference line was determined considering the presumed original surface level as tumor surface.

Size

Axial, coronal T2WI, and post-contrast T1WI were used for measuring the size of the lesion. The lesion appears slightly T2WI hyperintense while T1WI isointense to surrounding mucosa which renders the lesion difficult to identify. Axial and coronal images were taken to measure maximum three-dimensional sizes and the lesion was staged under category T of TNM staging criteria of carcinoma oral cavity.

Lymph nodal metastasis

Before diffusion-weighted MR imaging, T1-weighted and T2-weighted fast spin-echo images were obtained in the transverse plane. After that, diffusion-weighted MR images were obtained at the level where the largest transverse section of the lesion was identified on MR images before administration of contrast material.

An electronic cursor in the standard software imager was used to define the Region of Interest (ROI) in each patient and the ADC value was automatically reconstructed.

While performing diffusion-weighted MR imaging, obvious cystic portions and calcified areas were avoided. The image distortion caused by susceptibility artifacts and the severity of chemical shift artifacts was reduced and the sequence repeated if any sequence was judged sub-optimal by the radiologist.

RESULTS

Table 1. Distribution of patients according to their final site of malignancy

Final Site	Final subsite	Frequency	Percent
Carcinoma alveolus (n=7, 12.5%)	Left lower alveolus	3	5.4
	Right lower alveolus	4	7.1
Carcinoma buccal mucosa (n=29, 51.8%)	Left Buccal Mucosa	14	25
	Right Buccal Mucosa	9	16.1
	Left retromolar trigone	4	7.1
	Right retromolar trigone	2	3.6
Carcinoma gingivobuccal sulcus (n=3, 5.4%)	Left gingivobuccal sulcus	1	1.8
	Right gingivobuccal sulcus	1	1.8
	Upper and lower gingivobuccal sulcus	1	1.8
Carcinoma lip (n=2, 3.6%)	Lower lip	2	3.6
Carcinoma tongue (n=15, 26.8%)	Left lateral border of tongue	5	8.9
	Right lateral border of tongue	7	12.6
	Bilateral halves of tongue	1	1.8
	Right half	2	3.6
Total		56	100

Table 2. Association between radiological tumor staging and clinical staging

	Clinical T				Total
MRI T	**1.0**	**2.0**	**3.0**	**4.0**	
1.0	3	0	0	0	3
2.0	1	16	2	2	21
3.0	0	5	5	11	21
4.0	0	2	2	7	11
Total	4	23	9	20	56
	chi square p value < 0.001; kappa = 0.37				
	Clinical N			**Total**	
MRI N	**0.0**	**1.0**	**2.0**		
0.0	20	6	0	26	
1.0	7	5	0	12	
2.0	8	10	0	18	
Total	35	21	0	56	
	chi square p value = 0.08; kappa = 0.12				
	C-Stage				**Total**
MRI stage	**I**	**II**	**III**	**Iva**	
I	3	0	0	0	3
II	1	6	3	0	10
III	0	6	6	6	18
IVa	0	5	6	14	25
Total	4	17	15	20	56
	chi square p value < 0.01; kappa = 0.31				

Table 3. Association between histological tumor staging and clinical staging

	Histological T				Total
Clinical T	**1.0**	**2.0**	**3.0**	**4.0**	
1.0	4	0	0	0	4
2.0	1	14	7	1	23
3.0	0	5	2	2	9
4.0	0	5	6	9	20
Total	5	24	15	12	56
	chi square p value < 0.001; kappa = 0.31				
	Histological N			**Total**	
Clinical N	**0.0**	**1.0**	**2.0**		
0.0	21	5	9	35	
1.0	7	4	10	21	
Total	28	9	19	56	
	chi square p value = 0.14; kappa = 0.11				
	Histological stage				**Total**
Clinical stage	**I**	**II**	**III**	**IVa**	
I	4	0	0	0	4
II	0	9	3	5	17
III	0	4	5	6	15
IVa	0	1	3	16	20
Total	4	14	11	27	56
	chi square p value < 0.01; kappa = 0.43				

Table 4. Association between histological tumor staging and radiological staging

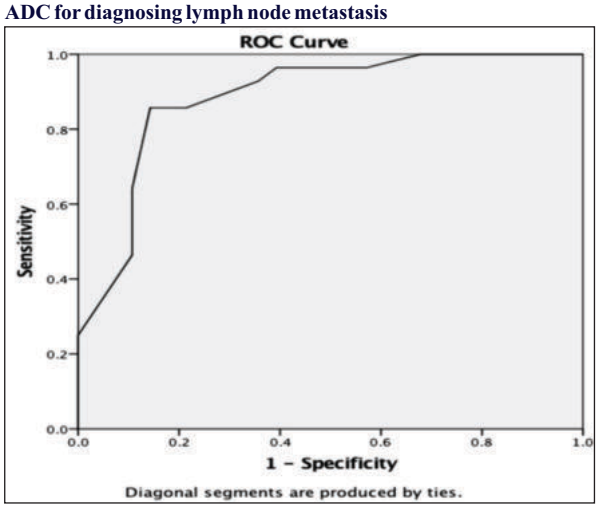
	Histological T				Total
MRI T	**1.0**	**2.0**	**3.0**	**4.0**	
1.0	3	0	0	0	3
2.0	2	16	3	0	21
3.0	0	6	10	5	21
4.0	0	2	2	7	11
Total	5	24	15	12	56
	chi square p value < 0.001; kappa = 0.48				
	Histological N			**Total**	
MRI N	**0.0**	**1.0**	**2.0**		
0.0	25	1	0	26	
1.0	3	8	1	12	
2.0	0	0	18	18	
Total	28	9	19	56	
	chi square p value < 0.01; kappa = 0.85				
	Histological stage				**Total**
MRI stage	**I**	**II**	**III**	**Iva**	
I	3	0	0	0	3
II	1	8	1	0	10
III	0	5	9	4	18
IVa	0	1	1	23	25
Total	4	14	11	27	56
	chi square p value < 0.01; kappa = 0.65				

Table 5. Diagnostic accuracy of detecting lymph nodes metastasis on MRI

LN metastasis detected on MRI	LN metastasis detected intra-operatively		Total
	Yes	No	
Yes	27	3	30
No	1	25	26
Total	28	28	56

Sensitivity 96.40%
Specificity 89.20%
Positive predictive value90%
Negative predictive value 96.10%
Accuracy 92.80%

Graph 1. Receiver Operating Characteristic curve analysis of ADC for diagnosing lymph node metastasis



We calculated the cut-off value of 1.15 x10^{-3} mm^2/s for ADC on ROC analysis. For diagnosing metastatic lymph nodes, the area under the curve was found to be 0.88 ± 0.04, 95% confidence intervals 0.79 to 0.97, p value < 0.001.

Table 6. Accuracy of diagnosing lymph node metastasis based on ADC

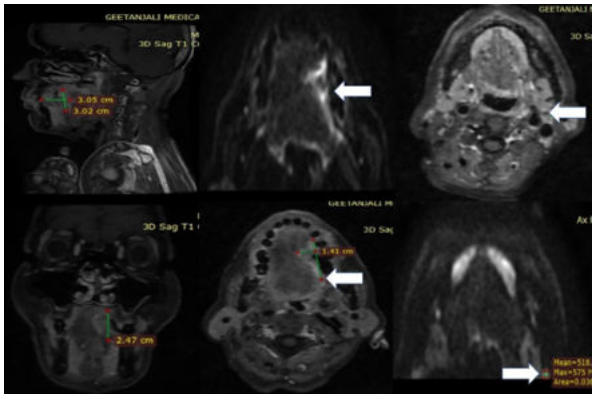
Based on ADC cut-off of 1.15 x10^{-3} mm^2/s	Intra-operative	
	Metastasis	No Metastasis
Metastasis	24	4
No Metastasis	4	28

Sensitivity 85.71%
Specificity 85.19%
Positive predictive value 86%
Negative predictive value 85.19%
Accuracy 85.45%

Using the cut-off value of 1.15 x10^{-3} mm^2/s for ADC, lymph node metastasis was present in 28 cases. Based on this, ADC with cut-off value less than 1.15 has a sensitivity of 85.7%, specificity of 85.1%, and overall accuracy of 85.4%.

CASES

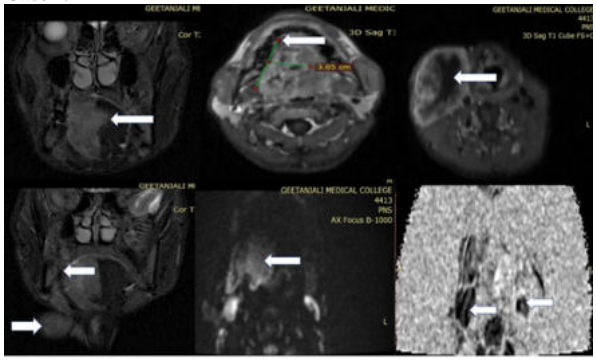
Case 1:



Carcinoma tongue

- Contrast enhanced T1, T2 and STIR sequences show a T2/STIR hyperintense ulcerated area with significant restriction on diffusion involving left lateral border and anterior 2/3rd of left half of tongue. Post contrast images reveals significant enhancement. Max dimension <4cm, however Depth of invasion is 14mm. No evidence of any extension into the retromolar trigone. No evidence of any body erosion. A lymph node of size 15mm in SAD and ADC value 0.6 x10-3 mm2/s is seen in left level 1B.
- *Staged as TNM III (T3N1M0) with final histopathological report confirming the lymph nodal spread.*

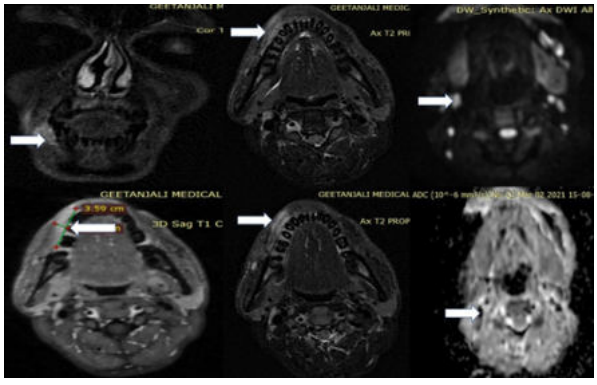
Case 2:



Carcinoma tongue

- There is a large abnormal signal intensity lesion (65mm x 26mm x 47mm) involving tongue, predominantly right half also crossing midline to involve left half appearing hypointense on T1 and hyperintense on STIR sequence. Post contrast scans show heterogeneous enhancement. The mass lesion extends posteriorly to involving base of tongue and right vallecula and inferiorly to infiltrate adjacent floor of mouth. Abnormal marrow signals noted in the body of mandible, appearing hyperintense on STIR sequence, possibly suggesting infiltration. There are multiple enlarged enhancing centrally necrotic right sided level Ib, III, IV, V & VII and bilateral II cervical lymph nodes, largest measuring 59mm x 43mm.

Case 3:



Carcinoma right buccal mucosa.

- There is altered signal intensity lesion of size 30mm x 25mm x 9mm (Depth of invasion- 9mm) noted in the right buccal mucosa which appears hyperintense on T2W and STIR sequence and showing partial diffusion of restriction. On post contrast study it is showing heterogeneous enhancement. It is extending into the adjacent portion of the subcutaneous tissue and reaching up to the skin involving the lower lip. Posteriorly, it is not extending to the RMT or masticator space. No obvious bone erosion is noted. Sub centimeter sized lymph nodes are noted in the bilateral level Ib and II, largest measuring 8.5 mm in left level Ib with ADC value of 0.9 x10-3 mm2/s, while the rest showed values of 1.4 to 1.7 x10-3 mm2/s.
- *Staged as TNM IVa (T4aN2aM0) with final histopathological staging proving the single ipsilateral metastatic lymph node.*

DISCUSSION

In our study, mean age of the patients was 47.8 ± 11.05 years, ranging from 30 to 78 years. In addition, 80.4% of the patients were males.

We observed that there was a fair level of agreement between clinical T and histological T (kappa = 0.31) and moderate agreement between overall clinical staging and overall histological staging (kappa = 0.43). Ravikanth reported that the agreement for the T stage was poor (k = 0.012) between the clinical and histopathology staging assessments. Agreement for the N stage was poor (k = 0.091) between the clinical and histopathology staging assessments.

In our study, there was a moderate level of agreement between MRI T and histological T (kappa = 0.48), near perfect agreement between MRI N and histological N (kappa = 0.85) and substantial agreement between overall MRI staging and overall histological staging (kappa = 0.65).

In the study by Amandeep et al, good/substantial (k=0.790) agreement for the T stage was seen between MRI and histopathology staging assessments.[7] The agreement for the N stage was moderate (k=0.458) between MRI and histopathology staging assessments. The agreement for the T stage was poor (k=0.085) between the clinical and histopathology staging assessment.[8]

Depth of invasion

In our study, mean depth of invasion calculated histologically (8.8 ± 7.33), which was significantly less than mean depth calculated on MRI was 10.48 ± 5.95, p value < 0.01. The shrinkage factor calculated was 84.5%.

Lawein et al suggested that there is tumor shrinkage after resection affecting all oral cavity subsites, including the oral tongue. The tumor shrinkage factor for oral tongue cancer has been reported to be 87%.[9]

In a similar study, Goel et al reported that the average depth of invasion calculated on MRI was 8.47mm and by histopathology was 6.85mm.[2] Pearson's correlation coefficient was 0.988. Shrinkage factor was 0.8 in their study.

Ravikanth observed that the mean depth of invasion by histology and MRI was14.22 mm and 16.12 mm, respectively.[10] Moderate agreement (k = 0.541) was noted between clinical and pathological tumor depth and good agreement (k = 0.844) was noted between radiological and pathological tumor depth. The correlation between depth of invasion reported on MRI and pathologic depth of invasion (r = 0.93; P <0.001).

Detection of lymph node metastasis on MRI

We observed that MRI had a sensitivity of 96.4%, specificity of 89.2% and overall diagnostic accuracy of 92.8% for diagnosing metastatic lymph nodes.

In a recent study, Laimer et al determined the diagnostic accuracy of MRI for detecting cervical lymph node metastases in oral squamous cell carcinoma patients.[12] They reported that MRI had a sensitivity of 85.7%, specificity of 75.6%, positive predictive value of 68.6% and negative predictive value of 89.5%.

Mean ADC values and its ability to detect lymph node metastasis

In our study, mean ADC was 0.84 ± 0.28 $x10^{-3}$ mm^2/s) in patients with metastatic lymph nodes. It was significantly lower than patients who did not have metastatic lymph nodes (1.3 ± 0.22 $x10^{-3}$ mm^2/s), p value < 0.001. In addition, using the cut-off value of 1.15 $x10^{-3}$ mm^2/s for ADC, lymph node metastasis was present in 28 cases. Based on this, ADC with cut-off value less than 1.15 $x10^{-3}$ mm^2/s has a sensitivity of 85.7%, specificity of 85.1%, and overall accuracy of 85.4%.

In a comparable study, Goel et al reported that the mean ADC value for malignant and benign lymph nodes was 0.84 ± 0.15 $x10^{-3}$ mm^2/s and 1.23 ± 0.12 $x10^{-3}$ mm^2/s respectively.[2] Cut off value to discriminate between malignant and benign lymph nodes was 1.39 $x10^{-3}$ mm^2/s in the present study. The sensitivity, specificity and accuracy of DWI in predicting cervical lymph nodal metastasis was 94.44%, 96% and 95.08% respectively when compared with histopathology.

CONCLUSION

Based on the results of the study, we conclude that: MRI T and overall staging had fair level of agreement with clinical T and staging. MRI T had moderate agreement with histological T, near perfect agreement with N and substantial agreement for overall staging. MRI had a sensitivity of 96.4%, specificity of 89.2% and overall diagnostic accuracy of 92.8% for detecting lymph node metastasis.

We recommend that MRI could be considered an important supportive tool to differentiate between benign and malignant cervical lymph nodes in patients with oral squamous cell carcinoma.

REFERENCES

1. Global Cancer Observatory [Internet]. Gco.iarc.fr. 2019 [cited 3 November 2019]. Available from: http://gco.iarc.fr/
2. Goel V, Parihar PS, Parihar A, Goel AK, Waghwani K, Gupta R, Bhutekar U. Accuracy of MRI in prediction of tumour thickness and nodal stage in oral tongue and gingivobuccal cancer with clinical correlation and staging. Journal of clinical and diagnostic research: JCDR. 2016 Jun;10(6):TC01-–TC05.
3. Mahajan A, Vaidya T, Desai S. 8th edition AJCC and imaging TNM: Time to break-in and assert in the staging process!. Indian Journal of Cancer. 2019;56(3):271.
4. Thankappan K, Subramaniam N, Anand A, Balasubramanian D, Iyer S. Implementing American Joint Committee on Cancer 8th edition for head-and-neck cancer in India: Context, feasibility, and practicality. Indian Journal of Cancer. 2018;55(1):4.
5. Ebrahimi A, Gil Z, Amit M, Yen T, Liao C, Chaturvedi P, Agarwal J, Kowalski L, Kreppel M, Cernea C, Brandao J, Bachar G, Bolzoni Villaret A, Fliss D, Fridman E, Robbins K, Shah J, Patel S, Clark J. Primary Tumor Staging for Oral Cancer and a Proposed Modification Incorporating Depth of Invasion. JAMA Otolaryngology–Head & Neck Surgery. 2014;140(12):1138.
6. Faisal M, Abu Bakar M, Sarwar A, Adeel M, Batool F, Malik K, Jamshed A, Hussain R. Depth of invasion (DOI) as a predictor of cervical nodal metastasis and local recurrence in early stage squamous cell carcinoma of oral tongue (ESSCOT). PLOS ONE. 2018;13(8):e0202632.
7. Singh A, Thukral CL, Gupta K, Sood AS, Singla H, Singh K. Role of MRI in evaluation of malignant lesions of tongue and oral cavity. Polish journal of radiology. 2017; 82:92-99.
8. Valecha J, Ojha S, Tripathi P. Role of MRI in evaluation of oral cavity cancers from central India. Int J Med Res Rev 2018;6(05):285-291.
9. Lwin CT, Hanlon R, Lowe D, Brown JS, Woolgar JA, Triantafyllou A, Rogers SN, Bekiroglu F, Lewis-Jones H, Wieshmann H, Shaw RJ. Accuracy of MRI in prediction of tumour thickness and nodal stage in oral squamous cell carcinoma. Oral Oncology. Oral Oncol. 2012 Feb;48(2):149-54.
10. Ravikanth R. MR evaluation of tongue carcinoma in the assessment of depth of invasion with histopathological correlation: A single center experience. Indian J Radiol Imaging 2020;30:126.38.
11. Patel SG, Amit M, Yen TC, Liao CT, Chaturvedi P, Agarwal JP, Kowalski LP, Ebrahimi A, Clark JR, Cernea CR, Brandao SJ. Lymph node density in oral cavity cancer: results of the International Consortium for Outcomes Research. British journal of cancer. 2013;109(8):2087-95.
12. Laimer J, Lauinger A, Steinmassl O, Offermanns V, Grams AE, Zelger B, Bruckmoser E. Cervical Lymph Node Metastases in Oral Squamous Cell Carcinoma—How Much Imaging Do We Need?. Diagnostics. 2020;10(4):199.