

Original Research Article

**MULTIDETECTOR COMPUTED TOMOGRAPHY IN
EVALUATION OF CARTILAGE INVOLVEMENT IN STAGES
3 AND 4 LARYNGEAL AND HYPOPHARYNGEAL
CARCINOMA**

Dr. Jayalatha Nethagani¹, Dr. Priyanka Govula², Dr. Kotha Swapna³, Dr. Goura Praveena⁴

¹Director and Professor, Department of Radiodiagnosis, MNJ Institute of Oncology and Research Cancer Center, Hyderabad, Telangana, India.

²Assistant Professor, Department of Radiodiagnosis, MNJ Institute of Oncology and Research Cancer Center, Hyderabad, Telangana, India.

³Assistant Professor, Department of Radiodiagnosis, MNJ Institute of Oncology and Research Cancer Center, Hyderabad, Telangana, India.

⁴Assistant Professor, Department of Radiodiagnosis, MNJ Institute of Oncology and Research Cancer Center, Hyderabad, Telangana, India.

Corresponding Author

Dr. Jayalatha Nethagani, Assistant Professor, Department of Radiodiagnosis, MNJ Institute of Oncology and Research Cancer Center, Hyderabad, Telangana, India.

Received: 28-11-2023 / Revised: 03-12-2023 / Accepted: 01-01-2024

ABSTRACT

Background

Imaging has an important role in the evaluation of laryngeal and hypopharyngeal cancers which adds to the clinical examination. Multidetector computed tomography (MDCT) depicts the anatomy of the larynx and characteristic patterns of submucosal tumor extension. Laryngectomy and organ preservation with chemo-radiation are presently the two most accepted treatments for locally advanced laryngeal cancer. The precise pre-treatment assessment of cartilage invasion is crucial for facilitating therapeutic decision making

Methods

This prospective study of multidetector computed tomography in evaluation of cartilage involvement in stages 3 and 4 laryngeal and hypopharyngeal carcinoma was conducted at MNJ Institute of Oncology and Regional Cancer Centre, Hyderabad. A total of 70 patients of stage 3 & 4 laryngeal and hypopharyngeal cancers who presented for pre therapeutic MDCT neck evaluation in our institute over a period of 120 days.

Results

Total of 70 patients were included in the study. Most commonly affected group of patients were within the age group of 50-59 years. Among them, males were 78.57% and females were

21.43%. Out of 70 patients, 59 were laryngeal cancers and 11 were hypopharyngeal cancers. Thyroid cartilage is most commonly involved in our study. Cartilage involvement was more common in supraglottic cancers and cartilage invasion was the most common presentation.

Conclusion

MDCT offers a comprehensive and practical preoperative diagnostic assessment. It has immensely contributed to the staging and treatment planning of stage 3 and 4 laryngeal and hypopharyngeal cancers. Those cancers without cartilage erosion are treated with laryngeal organ preservation protocols.

Keywords: Multidetector computed tomography, cartilage, laryngeal cancers, hypopharyngeal cancers.

INTRODUCTION

Laryngeal cancer is the second most common malignancy after oral cavity of head and neck cancers.^[1] These malignancies commonly arise from the epithelial lining of larynx with squamous cell carcinoma being most common histological type.^[2] Hypopharyngeal malignancies are less common than laryngeal cancers.^[3] Incidence is more common in males.^[4] Major risk factors being smoking, tobacco and alcohol.³ Due to these common risk factors they are associated with lung and aero digestive tract cancers.^[4]

The origin of these cancers is usually mucosal and then infiltrate underlying submucosal tissues. Initially they spread along the pathways of least resistance into the soft tissue and in later stages they invade the bone and cartilage.^[3] Lymphatic involvement is more common in supraglottic and hypopharyngeal malignancies. As glottis is avascular structure, glottic tumours do not usually spread to neck nodes. Most common distant metastasis is to lung, followed by bones and liver.^[3]

Transglottic cancer is the involvement of both the glottis and supraglottis, irrespective of subglottic involvement.^[4] Hoarseness, difficulty in breathing, dysphagia, or odynophagia, foreign body sensation, ear ache and stridor or aspiration in advanced disease are the presenting symptoms.^[5]

MDCT with iv contrast is the modality of choice for laryngeal and hypopharyngeal cancers as it is widely available, cheaper, faster, less prone to swallowing artefacts and provides better spatial resolution.^[4]

According to eighth edition of American joint committee on cancer staging system (AJCC) invasion of inner cortex of thyroid cartilage is considered T3 and invasion of outer cortex of thyroid cartilage and invasion of cricoid cartilage as T4a.^[6]

Cartilage invasion is a crucial criterion for diagnosing advanced stages of disease and determining the appropriate treatment. Cartilage involvement was assessed using the CT criteria found by Becker et al. Sclerosis is defined as obvious thickening of the ossified inner or outer cortex or increased ossification of medullary cavity, erosion or lysis as punched out lesion or focal lytic defect within sclerotic bone marrow comparable to osteolysis and extralaryngeal spread as major cartilage destruction with tumor on inner and outer aspect of cartilage.^[7]

Early stages without cartilage involvement are treated with laryngeal preservation surgery. Stages with limited local cartilage invasion may require partial laryngectomy with function preservation or chemoradiotherapy. In advanced stages total laryngectomy is necessitated.^[8]

AIMS & OBJECTIVES

The aim of the study is to assess the involvement of cartilage in patients with stages 3 and 4 laryngeal and hypopharyngeal cancers using contrast enhanced multidetector computed tomography of neck. Based on the CT imaging characteristics, cartilage involvement was categorised into no involvement, penetration, erosions and sclerosis.

MATERIAL AND METHODS

The prospective study was conducted in the Department of Radiodiagnosis at MNJ Institute of Oncology and Regional Cancer Center, Hyderabad from March 2022 to June 2022. Patients were followed up to therapeutic / biopsy diagnosis.

Inclusion Criteria

1. Patients with stage 3 and 4 laryngeal and hypopharyngeal cancers.

Exclusion criteria

1. Patients with carcinoma larynx and hypopharynx post-radiotherapy, post-chemotherapy or recurrence.
2. Pregnant females
3. Patients with deranged renal functional tests.

Informed consent was taken from each patient prior to the scan. Subjects were scanned using SIEMENS 128CT Scanner (SOMATOM DEFINITION) in supine position.

After performing plain CT axial scanning from the skull base to the aortic arch, then, 50-60ml of non-ionic contrast with concentration of 300mg/ml of iodine was injected at the rate of 4ml/sec and study was acquired in arterial and venous phase. Multiplanar reconstructed images were then interpreted.

RESULTS

Total of 70 patients were included. Most commonly affected patients were within the age group of 50 to 59 years (37.14%). Most of them were males (55) and females were (15). Most common malignancy was laryngeal cancer (84.2%) and second most common was hypopharyngeal cancer (15.7%). Supra glottic involvement is the most common presentation seen in 48.57% patients, out of which 88.2% were males. Cartilage invasion seen in 47 cases (67.14%), penetration is seen in 19 cases (40.4%), erosion is seen in 24 cases (51%), sclerosis is seen in 43 cases (91.4%). Extra laryngeal tumor extension through cartilage seen in 22 cases (46.8%). Carcinoma supra glottis with extra laryngeal spread seen in 8 cases (36.36%). Thyroid cartilage is most commonly involved (52.8%), cricoid cartilage was less commonly involved (27.1%) in our study.

Gender	Number of Patients	Percentage
Males	55	78.57%
Females	15	21.43%

Table 1. General Characteristics

Age Group	No. of Cases	Percentages
30-50 years	11	15.7%
50-60 years	26	37%
60-70 years	16	22.8%
>70 years	17	24.2%

Table 2. Age Group

Segment Involved	Number of Patients	Percentage
Supraglottis	34	48%
Glottis	18	26%
Transglottis	7	10%
Hypopharynx	11	16%

Table 3. Segment Involved

Cartilage	No Involvement	Penetration	Erosion	Sclerosis
Thyroid Cartilage	33	27	6	4
Cricoid Cartilage	51	2	8	9
Arytenoid Cartilage	40	3	7	20

Table 4. Cartilage Involvement

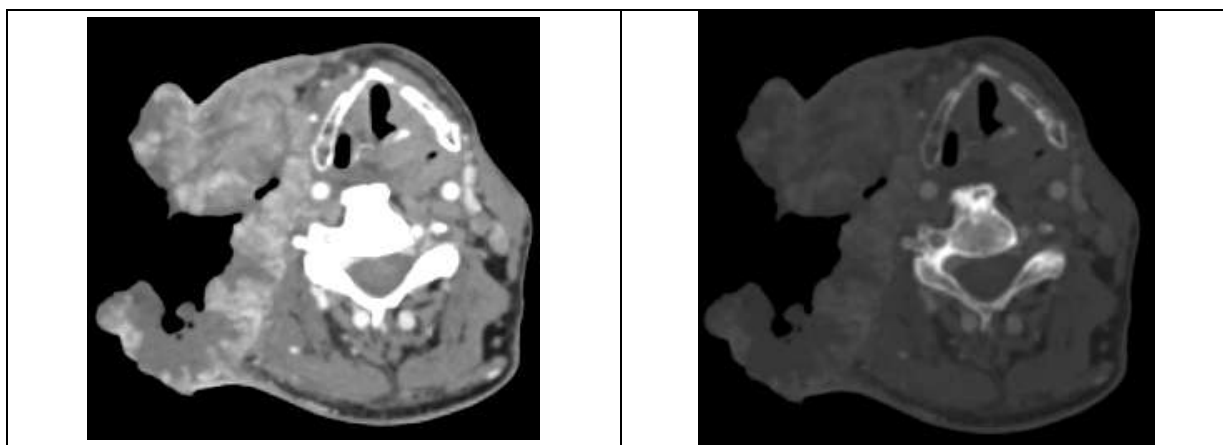


Figure 5(a) and 5(b): Axial CECT and CT bone images at the level of thyroid cartilage in a case of Ca supraglottis shows sclerosis of left thyroid cartilage and a large necrotic conglomerated right cervical lymphodal deposit

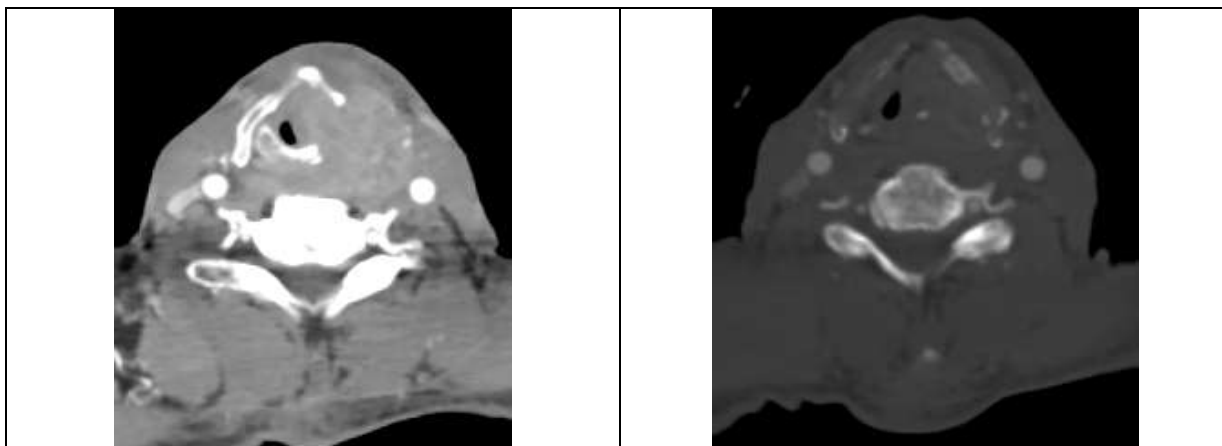


Figure 6(a) and 6(b): Axial CECT and CT bone images at the level of thyroid cartilage in a case of Ca Glottis shows invasion of left thyroid cartilage with penetration into extralaryngeal space.

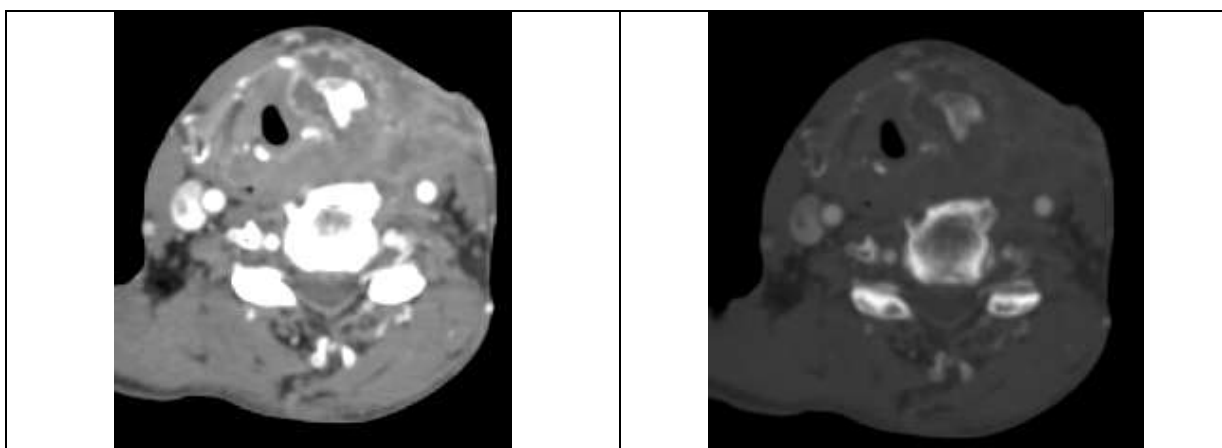


Figure 7(a) and 7(b): Axial CECT and CT bone images at the level of thyroid cartilage in a case of Ca hypopharynx shows invasion and sclerosis of left thyroid cartilage with penetration into extralaryngeal space.

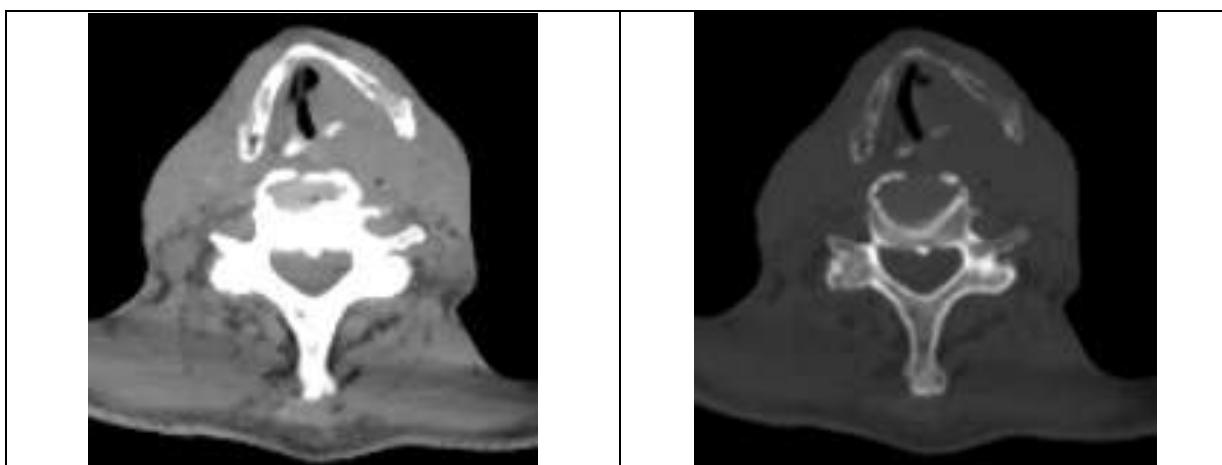


Figure 8 (a) and 8(b): Axial CT and CT bone images at the level of thyroid cartilage in a case of Ca supraglottis and transglottis shows erosions of left thyroid cartilage

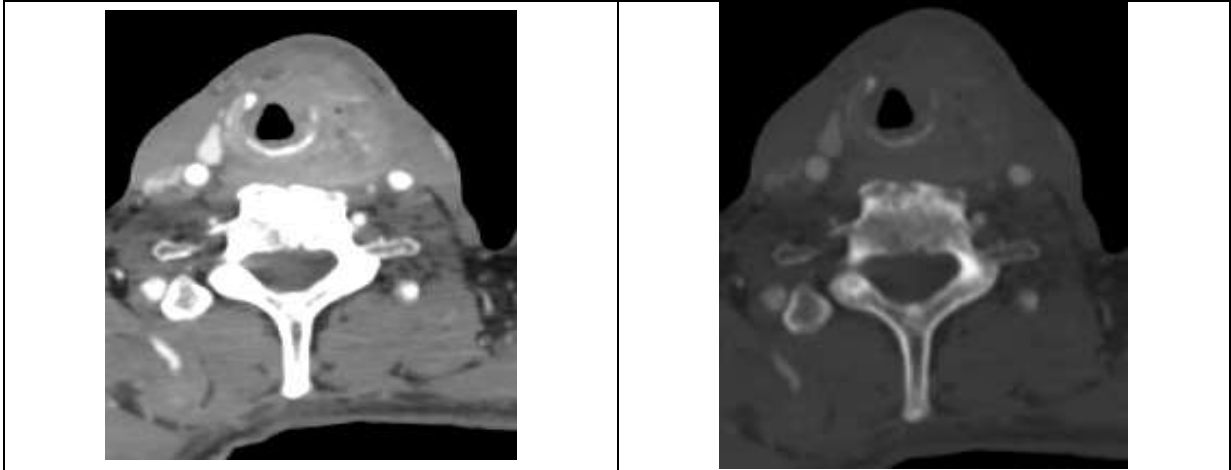


Figure 9(a) and 9(b): Axial CECT and CT bone images at the level of cricoid cartilage in a case of Ca transglottis shows invasion of cricoid cartilage and penetration of lesion into extralaryngeal space

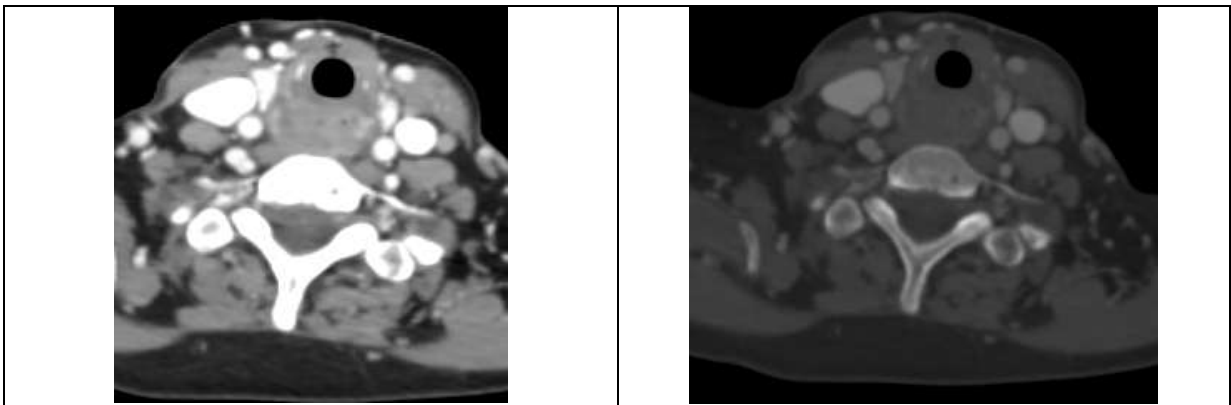


Figure 10(a) and 10(b): Axial CECT and CT bone images at the level of cricoid cartilage in a case of Ca hypopharynx shows invasion of cricoid cartilage

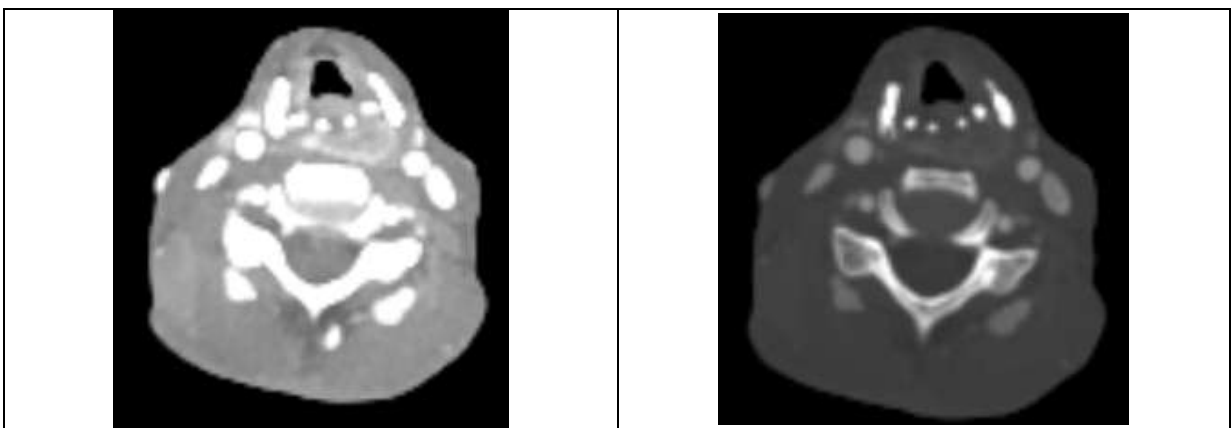


Figure 11(a) and 11(b): Axial CECT and CT bone images at the level of arytenoid cartilage in a case of Ca hypopharynx shows sclerosis of bilateral arytenoid cartilages and thyroid cartilages

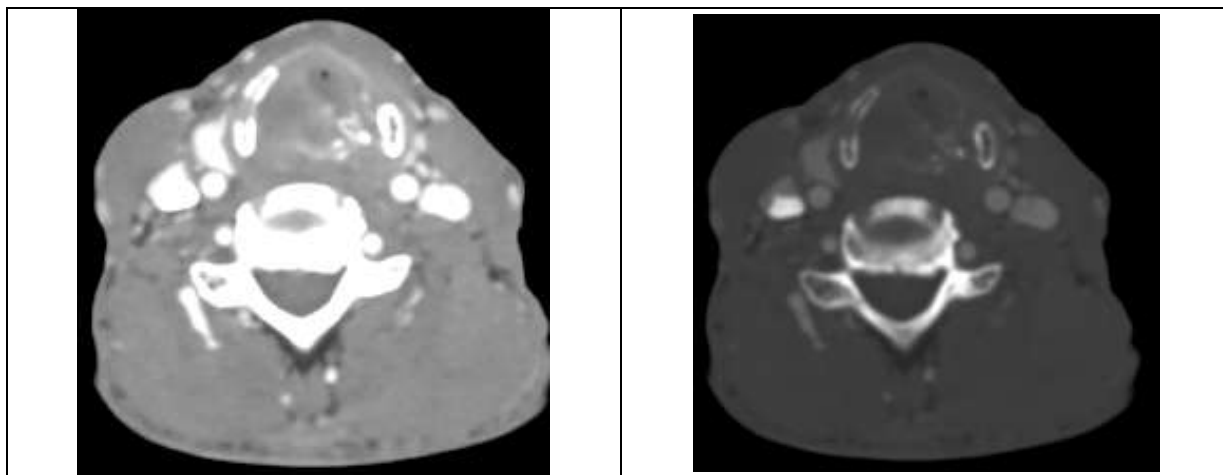


Figure 12(a) and 12(b): Axial CECT and CT bone images at the level of arytenoid cartilage in a case of Ca transglottis shows sclerosis and invasion of arytenoid cartilages

DISCUSSION

MDCT with contrast enhancement and bone window provide good imaging characteristic details in the evaluation of cartilage involvement and staging of laryngeal and hypopharyngeal cancers, but, nevertheless presents challenges. According to the proportions of hyaline cartilage (ossifies with aging), cortical bone and fatty marrow, the presentation of laryngeal cartilage on CT vary widely. Due to similar CT value of around 100 HU of nonossified cartilage and tumour, it is difficult to distinguish the tumour from non ossified cartilage when close to each other.^[3,9]

The criteria for reporting cartilage invasion on MDCT include presence of extralaryngeal spread, erosions and sclerosis.^[11,12] CT has high sensitivity (83%) to detect sclerosis in intracartiliginous disease, has a variable specificity from one cartilage to another, being lowest in the thyroid cartilage (40%) and higher in the cricoid(76%) and arytenoids cartilages(79%).^[12,13] Erosion and extralaryngeal tumor are highly specific criteria (86%-95%) for cartilage disease, sensitivity for erosion ranges from 64% and 72% and for extralaryngeal spread is 44% as they occur late in the course of the disease.^[13]

In our study out of 70 patients, most commonly affected were males (78.57%) which was in concordance with the study by Kathar MA et al.^[10] were 97% were males. The most common age group was 50-59(37%) with most of the patients aged above 40 years (95%) which was in concordance with the study by Kathar et al were 84% were between 40 and 70 years and Hirofumi Kuno et al.⁸ were patients affected above 40 years.

In our study, laryngeal involvement was more common (84.2%), of which supraglottis cancers (57.6%) being commoner than glottis (30.5%) and transglottis (11.8%). This was in concordance with Kathar MA et al. were Ca larynx was 75% and supraglottis was most commonly involved (63%).

The presence of cartilage infiltration is very important criterion as it determines the choice of treatment and influences the prognosis. Invasion of the cartilage is generally associated with a lower response rate to radiation therapy, with higher risk of recurrence, which can ultimately lead to a non functional larynx.

In our study, computed tomography revealed thyroid cartilage involvement was most common. Out of 70 patients, thyroid cartilage was involved in 37 patients (52.8%) out of which 27(72.9%) of them had penetration, 6 (16.2%) of them had erosions and 4 (10.8%) of them had sclerosis. This is in concordance with Kathar MA et al in which thyroid cartilage was most commonly involved. Penetration being the most common type of cartilage invasion in thyroid cartilage.

Out of 70 patients, arytenoids were involved in 30 (42.8%) patients, out of which 3(10%) of them had penetration, 7(23.3%) of them had erosions and 20(66.6 %) of them had sclerosis, hence sclerosis being most common type of involvement of arytenoids.

Cricoid cartilage was least involved in our study with 70 patients, 19(27.1%) being involved, out of which 2(10.5%) of them had penetration, 8(42.2%) of them had erosions and 9(47.3 %) of them had sclerosis.

CONCLUSION

MDCT gives comprehensive and most practical preoperative diagnostic information in determining the lesion, its extent, cartilage invasion and thus contributing to the staging and treatment planning of stage 3 and stage 4 in hypo pharynx and larynx cancers. CT has high potential in detecting erosions, sclerosis and penetration .Sclerosis has high specificity for arytenoid and cricoid cartilages and lowest for thyroid cartilage whereas penetration is more common in thyroid cartilage. Stages with limited local cartilage invasion may require partial laryngectomy with fuction preservation or chemoradiotherapy. Advanced stages with cartilage erosion and extralaryngeal spread needs to be treated with total laryngectomy.

REFERENCES

- [1] Imaging Recommendations for Diagnosis, Staging and Management of Larynx and Hypopharynx Cancer Arpita Sahu¹ Abhishek Mahajan² Delnaz Palsetia³ Richa Vaish⁴ Sarbani Ghosh Laskar⁵ Jyoti Kumar⁶ Namita Kamath⁷ Ashu Seith Bhalla⁸ Diva Shah⁹ Amit Sahu¹⁰ Ujjwal Agarwal³ Aditi Venkatesh³ Suman Kumar Ankathi¹ Amit Janu¹ Vasundhara Patil¹ Tejas H. Kapadia¹¹ Munita Ball¹² Shwetabh Sinha⁵ Kumar Prabhash¹³ A. K. Dcruz¹⁴
- [2] Dutta R, Husain Q, Kam D, Dubal PM, Baredes S, Eloy JA. Laryngeal Papillary Squamous Cell Carcinoma: A Population-Based Analysis of Incidence and Survival. *Otolaryngol Head Neck Surg.* 2015;153(1):54-9
- [3] Hermans R. Staging of laryngeal and hypopharyngeal cancer: value of imaging studies. *Eur Radiol* 2006;16(11):2386–2400
- [4] Joshi VM, Wadhwa V, Mukherji SK. Imaging in laryngeal cancers. *Indian J Radiol Imaging* 2012;22(03):209–226
- [5] Babu G, Prabhash K, Chaturvedi P, et al. Indian clinical practice consensus guidelines for the management of hypopharyngeal cancer. *Indian J Cancer* 2020;57(Supplement):S16–S18
- [6] American College of Surgeons. AJCC Cancer Staging Form Supplement. *AJCC Cancer Staging Manual, Eighth Edition.* 5 Jun 2018. Available at cancerstaging.org
- [7] Becker M, Neoplastic invasion of laryngeal cartilage: radiologic diagnosis and therapeutic implications. *Eur J Radiol* 2000;33:216–29

- [8] Evaluation of Cartilage Invasion by Laryngeal and Hypopharyngeal Squamous Cell Carcinoma with Dual-Energy CT Hirofumi Kuno , Hiroaki Onaya, Ryoko Iwata, Tatsushi Kobayashi, Satoshi Fujii, Ryuichi Hayashi, Katharina Otani, Hiroya Ojiri, Takeharu amanaka, Mitsuo Satake
- [9] Becker M, Zbären P, Delavelle J, et al.. Neoplastic invasion of the laryngeal cartilage: reassessment of criteria for diagnosis at CT. *Radiology* 1997;203(2):521–532. [Link](#), [Google Scholar](#)
- [10] Kathar MA, Michael RC, Shyam A, Mukhopadhyay S. Cartilage erosion in laryngeal and hypopharyngeal cancer correlation between radiology and histopathology. *Int J Otorhinolaryngol Head Neck Surg* 2018;4:913-7.
- [11] Beitler JJ, Muller S, Grist WJ, Corey A, Klein AM, Johns MM, et al. Prognostic accuracy of CT findings for patients with laryngeal cancer undergoing laryngectomy. *J Clin Oncol* 2010;28:2318–22.
- [12] Becker M, Zbären P, Delavelle J, Kurt AM, Egger C, Rüfenacht DA, et al. Neoplastic invasion of laryngeal cartilage: Reassessment of criteria for diagnosis at CT. *Radiology* 1997;203:521–32.
- [13] Zbaren P, Becker M, Lang H. Pretherapeutic staging of laryngeal carcinoma, Clinical findings, CT, and MRI compared with histopathology. *Cancer* 1996;77:1263–73