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Evaluation of Laryngeal Tumors by Multi-Detector Computed Tomography and Magnetic Resonance Imaging

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ABSTRACT

Background: Twenty to forty percent of all head and neck malignant tumors are laryngeal tumors, while sixty to seventy percent of laryngeal cancers are found at advanced stages. Laryngeal cancer is diagnosed using several techniques, such as magnetic resonance imaging (MRI) and contrast-enhanced Computed Tomography (CT).

Objective: The aim of this study was to evaluate the role of multislice computed tomography (MSCT) and magnetic resonance imaging (MRI) in diagnosis of laryngeal tumors.

Patients and methods: Twenty-four patients, 21 men and 3 women. Their ages ranged from 25 to 75 years who were referred form ENT department, Zagazig University Hospital. All patients underwent clinical examination, indirect laryngoscopic examination, CT, MRI and histopathological study.

Results: A highly significant difference was found between MRI and CT in masses and LNs finding among the studied patients by both MRI and CT. Both investigations agreed that 16.7 % of the studied patients had glottic mass, 12.5 % had glottic and infra glottic, and 41.7% had supra glottic and glottic with infiltration, degree of agreement in diagnosis of masses and LNs between both MRI and CT is very good (kappa= 0.775, p-value=0.000*). Agreement between CT and MRI regarding masses and LNs among the studied cases; glottic mass alone by CT 33.3% but by MRI 16.7% and glottic mass plus other sites and lymph nodes by CT 66.7% but by MRI 83.3%.

Conclusion: When it comes to T staging of laryngeal carcinomas, MRI shows greater accuracy than CT. Laryngeal carcinomas with AVC involvement may be better assessed for thyroid cartilage involvement and T stage if CT and MRI are used together.

Keywords: Laryngeal Tumors, Multi-Detector Computed Tomography, Magnetic Resonance Imaging.

INTRODUCTION

Twenty to forty percent of all head and neck malignant tumors are laryngeal tumors, while sixty to seventy percent of laryngeal cancers are found at advanced stages (III-IV). As of right now, video laryngoscopy combined with autofluorescence, contrast-enhanced CT, and MRI are all employed for diagnosing laryngeal cancer (rate of invasion). However, early-stage, tiny tumors do not respond well to these techniques for differential diagnosis. DWI-MRI is employed for accurate localization, growth and dissemination status (supraglottic and glottic tumors are found more commonly, while subglottic tumors are located less frequently). DWI is a cutting-edge method for finding laryngeal cancers, even the tiniest ones. Our study aims to determine how well DWI-MRI can detect laryngeal tumors [(1)].

MRI has been demonstrated to be useful in preoperative staging and assessment of glottic tumors in recent studies [(2)]. In clinical settings, contrast-enhanced computed tomography (CT) continues to dominate [(3)].

The uneven mixture of calcified, ossified, and non-calcified cartilage in the larynx makes CT imaging difficult, especially for identifying cartilage invasion. However, the therapeutic consequences of neoplastic invasion of the laryngeal cartilage are substantial. Involvement of cartilage decreases the efficacy of radiation and may rule out voice-saving surgery, making total laryngectomy necessary [(4, 5)].

CT has long been used for imaging of laryngo-hypopharyngeal cancer, despite the fact that MRI offers superior soft tissue differentiation and functional imaging ability. This is because CT is better at delineating the cortical disruption of ossified cartilage, and it also allows submillimeter images to be acquired with motion freezing in a matter of seconds. However, since cortical disruption may be required to detect cartilage invasion, uneven ossification frequently acts as a barrier to an accurate diagnosis. To get around this limitation, a recent study used dual-energy CT scans and iodine overlay pictures to tell tumors apart from non-ossified cartilage [(6)].

Radiology techniques including computed tomography (CT) and magnetic resonance imaging (MRI) can portray the laryngeal anatomy and detect malignancies with varying degrees of accuracy.

The availability of necessary equipment and knowledge determines which imaging modality can be used. While MRI's enhanced contrast resolution is helpful for evaluating the involvement of the skull base and intracranial structures, the unmineralized laryngeal cartilage, the paranasal sinuses, and some other soft tissues (such as the base of the tongue and the thyroarytenoid muscle), MRI is still prone to artefacts brought on by swallowing and movement. With a frantic patient who is short of breath and fidgeting, the time savings offered by CT are invaluable. Improved nodal coverage, superior assessment of cortical bone degradation, and the option to combine with chest imaging are further benefits [(6)].

It was the goal of this trial to assess the role of multi-slice computed tomography (MSCT) and MRI in

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diagnosis of laryngeal tumors staging, and to compare between multi-slices computed tomography (MSCT) and MRI in diagnosis and staging of laryngeal tumors.

PATIENTS AND METHODS

This study included a total of 24 patients having laryngeal lesions, with initial complaints of hoarseness of voice, dyspnea, and severe neck pain. They were referred from Department of ENT and Outpatient Clinic to Department of Radiodiagnosis, Zagazig University Hospitals.

Inclusion criteria: Adult patients who were suspected clinically as having laryngeal lesions.
Exclusion criteria: Previous history of allergic reaction to contrast media, renal dysfunction (Serum creatinine more than 1.6 mg/dl), unwilling patients to complete the study, patient with cardiac pacemaker, patient with claustrophobia, and patient who have metallic foreign body.

Ethical Consideration

An approval of the study was obtained from Zagazig University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

All studied patients **underwent the following:**

- Complete history taking: including Past history of ENT operation, chemo or radiotherapy
- Full clinical examinations, ENT examination: (1) Clinical examination of the neck to detect enlarged lymph nodes or absent tracheal tug. (2) Clinical findings were documented after an evaluation of the laryngeal mucosa, lumen, and mass pathology using an indirect laryngoscope. (3) During a general anesthetic, a direct laryngoscopy was performed, and biopsies were taken.
- **CT image acquisition:**

  Everyone who needed it had a multislice CT scan. A 128-channel, multidetector CT scanner was used for the CT examination.

  The target location was marked on a scouting map taken from the side. Imagery was taken from the top of the sphenoid sinus to the lower boundary of the sternoclavicular joints as part of a regular head and neck imaging study. To minimize artefacts at the thoracic inlet, scans were performed from the head to the feet. This allowed the contrast medium concentration in the subclavian vein, at the side of injection, to decline to a similar or slightly higher level compared to other neck vessels.

  After manually injecting 50 ml of a nonionic, low osmolar contrast agent (omnipaque), intravenously. During the entire CT scan, patients had to keep their breathing calm and not swallow.

  Scanning times varied between 8 and 12 seconds, with each individual holding their breath for a different amount of time.

  Whole-neck pictures in both the coronal and sagittal views were also taken. Additional images obtained during phonation or Valsalva's movements are required to distinguish specific alterations of the supraglottic larynx and the piriform sinus. Vocal folds are fully adducted and piriform sinuses are enlarged during phonation.

  After the end of examination images were reviewed for laryngeal skeleton including hyoid bone and laryngeal cartilages, true and false vocal cords, laryngeal soft tissue structures for any abnormality.

  A laryngeal tumor was defined as any area of increased soft tissue density that disrupts the larynx's typical symmetrical structure. Results from CT scans were correlated with those from clinical examinations, direct laryngoscopy, and biopsies and surgeries. Staging was performed locally using the TNM system established by the American Joint Committee on Cancer for head and neck cancers (AJCC).

Magnetic resonance imaging (MRI):

Superconductive General Electric MRI machines were used for all experiments (MRI Signa contour 1.5 tesla). Patients were instructed to remove jewelry and other metal objects, as well as to change into a special uniform with nonmetallic buttons, before undergoing an MRI. Patients were given information on how long the exam would go, how they should be lying down, and why they couldn't move at all. All patients underwent the procedure without requiring anaesthetic, and nobody had any anxiety or fear of being in a small space.

We employed either Omniscan or magnivist (Gadopentate Dimglumine - GD-DTPA) as our contrast medium. The dosage was 0.01m-mol/kg of body weight, and it was injected intravenously. Once the contrast injection was complete, T1W pictures were taken right away. Every single patient had a head and neck array coil placed on them. It took anything from 25 to 30 minutes to complete the whole exam.

The following procedure was followed for all cases: Direct laryngoscope and biopsy, Histopathology study of the biopsy were done to cases

Statistical analysis

In order to analyze the data acquired, Statistical Package of Social Services version 20 was used to execute it on a computer (SPSS). In order to convey the findings, tables and graphs were employed. The quantitative data was presented in the form of the mean, median, standard deviation, and confidence intervals. The information was presented using qualitative statistics such as frequency and percentage. The

student's t test (T) is used to assess the data while dealing with quantitative independent variables. Pearson Chi-Square and Chi-Square for Linear Trend (X^2) were used to assess qualitatively independent data. The significance of a P value of 0.05 or less was determined

RESULTS

This table showed that studied patients mean age was 60.67 ± 7.16 years, with a range from 53 to 75 years old, most of the studied patients were male (87.5 %).

Table (1): Demographics

Demographic data	Studied patients (N=24)	
	No.	%
Sex		
Male	21	87.5
Female	3	12.5
Age (years)		
Mean ± SD	60.67 ± 7.16	
Median (Range)	59(53-75)	

Table (2) shows that the most considerable clinical picture was hoarseness of voice in 62.5%, hoarseness of voice was accompted by difficult swallowing, dyspnea and stridor among (12.5%, 4.2% and 20.8 %) of cases respectively, dysphonia was found in 12.5 % of cases.

Table (2): Clinical picture of tumor among the studied group

Item	Studied gr (N=24)	
	No.	%
• Hoarseness of voice	15	62.5
• Difficult swallowing	3	12.5
• Dysphonia	3	12.5
• Stridor	5	20.8
• Dyspnea	1	4.2

Table (3) shows that squamous cell carcinoma was found in most of the studied **patient** among (87.5%) and adenocarcinoma was found in about 1/5 of case (12.5%).

Table (3): Histopathology among the studied tumors (N=24)

Item	Studied gr (N=24)	
	No.	%
Histopathology		
Adenocarcinoma	3	12.5
Squamous cell carcinoma	21	87.5

Table (4) shows that about 1/3 of the studied patients (29.2%) had LN affection. Transglottic (glottis and infraglottic) with infiltration and glottic mass were the predominant sites found among (41.7 & 33.3 %) of the studied patients respectively and transglottic (supraglottic and glottic) mass without infiltration of the surrounding cartilage or erosion of thyroid cartilage in 12.5% of the studied patient.

Table (4): CT finding among the studied patients (N=24)

Item	Studied patients (N=24)	
	No.	%
• LN affection	7	29.2%
• Glottic mass	8	33.3
• Glottic and infra glottis	3	12.5
• Glottic mass with erosion of thyroid cartilage	3	12.5
• Supra glottic and glottis with infiltration the surrounding structure	10	41.7

Table (5) shows that 16.7% of the studied patients had transglottic extension with LN or glottic mass with LNs and Supra glottic and glottic with infiltration of hyoid bone, glottic mass with erosion of thyroid cartilage with LNs or glottic and infra glottic mass without LNs were found in (12.5%) of the studied patients.

Table (5): MRI finding among the studied patients (N=24)

Item	Studied patients (N=24)	
	No.	%
• Glottic mass with erosion of thyroid cartilage with LNs	3	12.5
• Glottic and infra glottic mass without LNs	3	12.5
• Transglottic with LNs extension	4	16.7
• Glottic mass with LNs	4	16.7
• Supra glottic and glottic mass without LNs	3	12.5
• Supra glottic and glottic with infiltration of hyoid bone	4	16.7
• Supra glottic mass extend to glottic without LNs	3	12.5

Table (6) shows that a highly significant difference was found between MRI and CT in masses and LNs finding among the studied patients by both MRI and CT both tests agreed that 16.7 % of the studied patients had **glottic mass**, 12.5 % had **glottic and infra glottic**, and 41.7% had **supra glottic and glottic with infiltration,** degree of agreement in diagnosis of masses and LNs between both MRI and CT is very good (kappa= 0.775, p-value=0.000*).

Table (6): Agreement between CT and MRI regarding mass and LNs detection among the studied cases.

CT		MRI					p-value of test
	No	Glottic mass (A_1)	Glottic and infra glottis withsupra glottis extension with LNs (A_2)	Glottic and infra glottic (B)	Glottic mass with erosion of thyroid cartilage (C)	Supra glottic and glottic with infiltration (D)	
		(N=4)	(N=4)	(N=3)	(N=3)	(N=10)	
Glottic mass (A_1)	**8**	4 (16.7%)	**4 (16.7%)**	**0**	**0**	0	**0.000* (HS)**
Glottic and infra glottic (B)	**3**	0	0	3 (12.5%)	0	**0**	
Glottic mass with erosion of thyroid cartilage (C)	**3**	0	0	0	3 (12.5%)	**0**	
Supra glottic and glottic with infiltration (D)	**10**	0	0	0	0	10 (41.7%)	

Table (7) shows that glottic mass alone by CT 33.3% but by MRI 16.7% and glottic mass plus other sites and lymph nodes by CT 66.7% but by MRI 83.3%.

Table (7): Agreement between CT and MRI regarding masses and LNs among the studied cases.

Masses	CT	MRI
Glottic mass alone	**8 (33.3%)**	4 (16.7%)
Glottic mass plus other sites + LNs	16 (66.7%)	**20 (83.3%)**
Total	24 (100%)	24 (100%)

Table (8) shows that (25%) of the studied patients stage T3 N0 M0 , the most found was T2 N1 M0 among (33.3%) of the studied patients, followed by T3 N1 M0 in 16.7 % of the studied patients .

Table (8): MRI mass staging among the studied patients (N=24)

Item	Studied patients (N=24)	
	No.	%
• T2 N1 M0	8	33.3
• T2N0M0	3	12.5
• T3 N0 M0	6	25.0
• T3 N1 M0	4	16.7
• T3 N1 M1	3	12.5

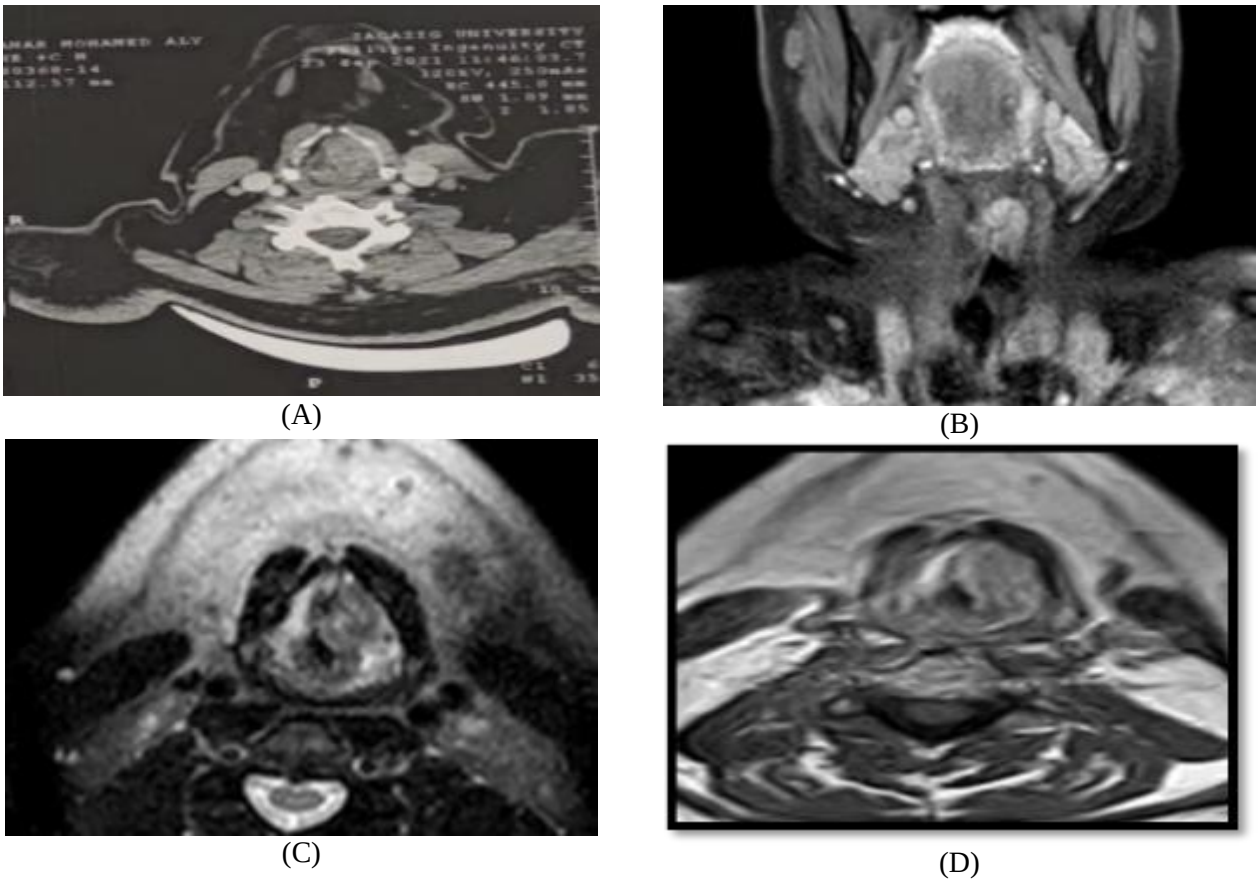

Fig. (1): Male patient about 63 years old suffering from difficulty of swallowing and hoarsness of voice. (Glottic and supraglottic carcinoma). A) Axial CT showed ill-defined soft tissue mass in the glottic and supra glottic spaces at the left side with narrowing of the air way, No bony involvement or cartilage destruction, MRI: B)Coronal T1 showed ill-defined soft tissue mass in the glottic and supra glottic spaces at the left side with narrowing of the air way, C)Axial T2w showed ill-defined soft tissue mass in the glottic and supra glottic spaces at the left side with narrowing of the air way, D) Axial T1 W showed ill-defined soft tissue mass in the glottic and supra glottic spaces at the left side with narrowing of the air way.

DISCUSSION

Nearly a quarter of all head and neck cancers and between one and five percent of all malignancies are tumors of the larynx. Cancer of the larynx is quite uncommon compared to cancer of the lungs. As the world's population ages, its prevalence rises, and the rise is widely attributed to shifting patterns of tobacco and alcohol use [(7)].

Imaging studies like CT and MRI can reveal both the internal and exterior characteristics of the disease. The availability, high cost, and prolonged scanning periods of MRI prevent it from being the first choice for imaging soft tissues. Although CT is commonly used and is generally considered reliable for making the diagnosis of thyroid cartilage invasion, it is not without its limitations [(8)]. Depending on the percentage of hyaline cartilage present, the CT look and value of thyroid cartilage will be varied. Both tumors and non-ossified cartilage have roughly the same CT value, about100 HU [(9)], making it difficult to tell one from the other, especially when the tumour is close to the softer, non-ossified cartilage.

The current study revealed that patients mean age was 60.67 ± 7.16 years, ranged from 53 to 75 years old, most of the studied patients were male (87.5 %).

The current study results were supported by **Reda *et al.*** [(10)] who analyzed the value of multi-slice CT and MRI for diagnosing laryngeal tumors. Thirty individuals of varying ages with a high suspicion for laryngeal malignancies participated in this prospective investigation. Ages of the 26 men and 4 women who participated in the study ranged from 40 to 75 (mean age 60.6 years). The affection with laryngeal tumors was predominant in males representing 86.7% of the total number of cases.

Regarding clinical picture of tumor among the studied group, the most considerable clinical picture was hoarseness of voice in 62.5%, hoarseness of voice

was accompanied by difficult swallowing, dyspnea and stridor (12.5%, 4.2% and 20.8 %) of cases respectively, dysphonia was found in 12.5 % of cases. This agrees with the study of by **Sarkar *et al.*** [11] who reported that the most common presenting symptom in their study was hoarseness of voice (87.8%), followed by difficulty in breathing (48.4%), dysphagia (33.3%), weight loss (24.2%), loss of appetite (18.1%), and neck swelling (15.1%).

Regarding the histopathology among the studied patients, we observed that squamous cell carcinoma was found in most of the studied patient (87.5%) and adenocarcinoma was found in (12.5) of cases. This agreed with **Warner *et al.*** [12] who reported that the histologic predominance of squamous cell carcinomas in all head and neck tumors.

Regarding CT finding among the studied patients, the current results showed that about (29.2%) of patients had LN affection.

In CT studies, transglottic (glottis and infraglottic) with infiltration to the surrounding structure and Glottic mass were the predominant sites found among (41.7 & 33.3 %) of the studied patients respectively and transglottic (supraglottic and glottic) mass without infiltration of the surrounding structure was 12.5%

Regarding MRI finding among the studied patients, we found that 16.7% of the patients had transglottic extension with LN or Glottic mass with LNs and supra glottic and glottic with infiltration of hyoid bone, Glottic mass with erosion of thyroid cartilage with LNs or Glottic and infra glottic mass without LNs were found in (12.5%) of the studied patients.

The current study results were supported by **Reda *et al.*** [10] who revealed that 28.6% of patients had transglottic extension: 28.6% had glottic with supra glottic extension, 21.4% had glottic only and 21.4% had supra glottic only. Glottic involvement is noted in 78.6% of cases.

When comparing CT and MRI for the detection of masses and LNs in the cases under study, MRI was shown to be significantly more accurate than CT.

Our results suggested that MRI had better preference in tumor staging than CT, as MRI can detect the early infiltration of the tumor to the surrounding structure and fatty infiltration.

Compared to CT, MRI has a far higher soft tissue resolution and the capability of multi-planar imaging, allowing for a more accurate assessment of a wider variety of pathological lesions and a more thorough examination of the submucosal dissemination of pathological processes [13].

This can be supported by **Reda *et al.*** [10] who reported that according to pathological T staging, CT and MRI had T staging accuracies of 66.7% and 86.4%, respectively, this matched with **Wu *et al.*** [14] who reported in their study that A large discrepancy exists between the accuracies of CT and MRI for T staging, with CT's being 57.69% and MRI's being 88.46% ($p<0.01$).

Our study showed also that MRI had good diagnostic potentials compared to CT where sensitivity of MRI in diagnosis of masses alone was 100 % and specificity was 80%, overall accuracy of MRI compared to CT was 83.3%.

And regarding MRI mass staging our results showed that most found prevalent stage was T2 N1 M0 among (33.3%) of the studied patients, followed by T3 N1 M0 in 16.7 % of the studied patients, the study by **Mohamed *et al.*** [15] compared to CT, MRI demonstrated superior validity and precision in detecting laryngeal cancer's invasion of the inner and outer thyroid lamina. In their study, they discovered that when CT and MRI were used simultaneously, the results increased both the readers' accuracy and their degree of trust.

Similarly, **Wu *et al.*** [14] found that T staging of laryngeal carcinomas including the anterior vocal commissure (AVC) was observed to be more accurately performed using MRI than CT. Laryngeal carcinomas with AVC involvement may be better assessed for thyroid cartilage involvement and T stage if CT and MRI are used together.

CONCLUSION

When it comes to T staging of laryngeal carcinomas, MRI shows greater accuracy than CT. Laryngeal carcinomas with AVC involvement may be better assessed for thyroid cartilage involvement and T stage if CT and MRI are used together.

When it comes to assessing tumor infiltration and spread in the local area, both imaging methods have their benefits and drawbacks. If used together, CT and MRI have the potential to eliminate limitations and increase accuracy, especially in the areas of thyroid cartilage evaluation and T staging of laryngeal carcinomas, Due to its great sensitivity and enhanced degree of diagnostic accuracy, MRI is increasingly being seen as the investigation of choice in the clinical evaluation of laryngeal tumors, especially early glottic lesions, for the planning of therapeutic measures.

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