Comparison of Videolaryngostroboscopy and Computed Tomography Findings with Histopathological Results in Larynx Cancers

Larenks Kanserinde Videolarengostroboskopi ve Bilgisayarlı Tomografi Bulgularının Histopatolojik Sonuçlarla Karşılaştırılması

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ABSTRACT Objective: The aim of this study was to investigate which diagnostic method was more efficient and reliable for preoperative T staging of laryngeal cancers by comparing videolaryngostroboscopy (VLS) and computed tomography (CT) findings with histopathologic examination of operation specimens. The main goal was to determine the most rational and accurate approach for preoperative evaluation and staging of larynx cancers. **Material and Methods:** This retrospective study included 58 patients operated on for larynx cancer. Preoperative VLS and CT findings were compared with histopathologic examination results of the operation specimens. The larynx was divided into 12 anatomical areas for this purpose. In addition, thyroid and cricoid cartilage invasion and extralaryngeal invasion parameters were included in the evaluation. Invasion of the tumor was identified by each evaluation method separately. Mobility of the vocal cords and arytenoids was evaluated with VLS. **Results:** CT was more effective than VLS in the evaluation of the paraglottic area, preepiglottic area, and subglottic area. CT was superior to VLS for the identification of thyroid involvement, cricoid cartilages and extralaryngeal invasion. VLS was more effective than CT for the assessment of the vocal cords and anterior commissure. Both diagnostic methods were effective for identification of tumor on the epiglottis. **Conclusion:** Success of VLS and CT changes according to the involvement of different anatomic areas. A combination of VLS and CT together, while taking into consideration the location of the tumor, improves accurate staging and consequently the surgical success.

Key Words: Laryngeal neoplasms; tomography, X-ray computed

ÖZET Amaç: Bu çalışmanın amacı, videolarengostroboskopi (VLS) ve bilgisayarlı tomografi (BT) bulgularını, operasyon materyallerinin histopatolojik değerlendirme sonuçlarıyla karşılaştırarak, larenks kanserlerinin preoperatif T evrelemesi için hangi tanısal yöntemin daha etkili ve güvenilir olduğunu araştırmaktı. Ana hedef, larenks kanserlerinin evrelemesi ve preoperatif değerlendirmesi için en akılcı ve doğru yaklaşımı saptamaktı. **Gereç ve Yöntemler:** Bu prospektif çalışmaya larenks kanseri nedeniyle opere edilmiş 58 hasta dahil edildi. Preoperatif VLS ve BT bulguları, operasyon materyallerinin histopatolojik değerlendirme sonuçlarıyla karşılaştırıldı. Bu amaçla larenks 12 anatomik alana ayrıldı. Ek olarak tiroit ve krikoid kıkırdak invazyonu ve ekstralarengeal invazyon parametreleri değerlendirmeye dahil edildi. Tümör invazyonu her değerlendirme yöntemi ile ayrı ayrı tanımlandı. Vokal kordların ve aritenoidlerin mobilitesi VLS ile değerlendirildi. **Bulgular:** BT paraglotik alan, preepiglotik alan ve subglotik alan değerlendirmesinde VLS'den daha etkili bulundu. Tiroit ve krikoid kıkırdakların tutulumu ve ekstralarengeal invazyonun tanımlanmasında da BT VLS'den daha üstündü. VLS, vokal kordların ve anterior komissürün değerlendirmesinde BT'den daha etkili bulundu. Her iki tanısal yöntem epiglottis üzerindeki tümörün tanımlanmasında etkiliydi. **Sonuç:** VLS ve BT'nin başarısı farklı anatomik bölgelerin tutulumuna göre değişir. Tümörün yerleşimi gözönüne alındığında, VLS ve BT'nin birlikte kullanılması, doğru evrelemeyi ve buna bağlı olarak cerrahi başarıyı arttırır.

Anahtar Kelimeler: Larinks tümörleri; tomografi, X-ray bilgisayarlı

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Partial functional conservative surgical techniques for the treatment of the larynx cancer have been developed to prevent patients from permanent stoma and phonation problems. The successful practice of these techniques results in both functional achievements and comparable survival rates. However, accurate pretherapeutic staging is required for optimal treatment planning and for the evaluation and comparison of the results of different surgical techniques.[1-5] Currently, it is possible to perform partial surgical techniques by preserving only an arytenoid and a part of the vocal cord. Hence, it is vitally important in the preoperative period to evaluate the tumoral mass in the larynx and determine the borders correctly.

Videolaryngostroboscopy (VLS) and computed tomography (CT) are commonly used for the preoperative evaluation of larynx cancer in addition to a routine ear-nose-throat (ENT) examination.[6-8] The aim of the present study was to assess the accuracy of preoperative CT and endoscopic evaluation by comparing imaging and endoscopic findings of each modality with histopathologic examination results for each anatomical subsite in larynx cancer. The main goal was to determine the most efficient diagnostic tool in each anatomical region for staging in larynx cancer.

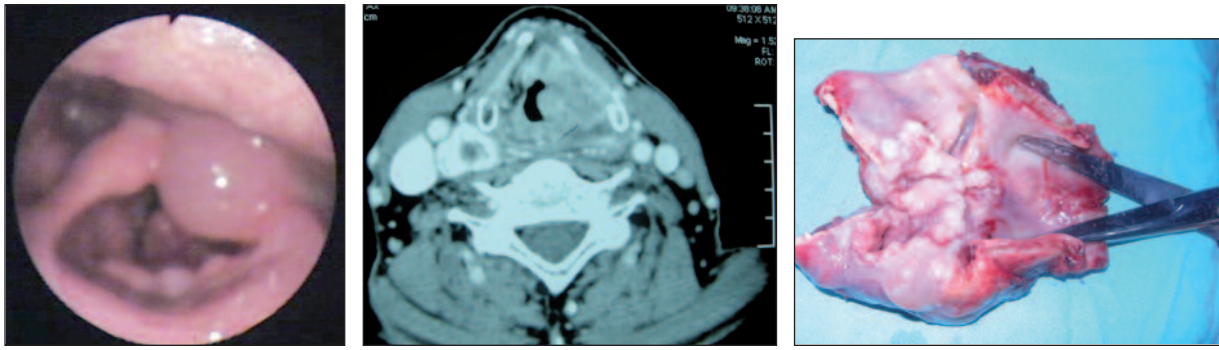
MATERIAL AND METHODS

Fifty-eight patients with larynx cancer who had undergone surgical intervention were included in this retrospective study. All patients were male with a mean age of 62 years (range, 44-76 years). The study was carried out according to the tenets of Declaration of Helsinki. Preoperative VLS and CT findings of the patients were compared with histopathologic examination results from the operation specimens. The larynx was divided into 12 anatomical areas for this purpose (Table 1). In addition, thyroid and cricoid cartilage invasion were included in the evaluation because they influenced treatment planning. Invasion of the tumor was identified by each examination method separately (Figure 1). Mobility of the vocal cords and arytenoids was evaluated with VLS. VLS was performed by using rigid and flexible telescopes. Lesions were evaluated by two ENT specialists (AT, GD).

TABLE 1: VLS, CT findings and histopathologic examination results of operation specimens.

	VLS				CT				
N= 58	**Tm + case**		**FP case**		**Tm + case**		**FP case**		
Involvement Area	**No.**	**Ratio**	**No.**	**Ratio**	**No.**	**Ratio**	**No.**	**Ratio**	**Histopathology**
Epiglottis	45	95%	0	0%	44	93%	1	2%	47
Aryepig. Pl.	14	93%	2	3%	11	73%	6	10%	15
Sinus priformis	9	81%	1	2%	10	90%	4	7%	11
Band ventricle	43	93%	1	2%	44	95%	0	0%	46
Ventricle	6	20%	3	5%	18	60%	3	5%	30
Vocal cord	42	87%	2	3%	30	62%	5	%8	48
Ant. comm.	23	79%	2	3%	19	66%	7	12%	29
Arytenoid	9	100%	2	3%	6	66%	0	0%	9
Subglot. Ar.	4	25%	1	2%	14	87%	5	8%	16
Postcric. Ar.	-	-	-	-	1	50%	0	0%	2
Preepig. Ar.	-	-	-	-	18	90%	0	0%	20
Paragl. Ar.	-	-	-	-	7	78%	0	0%	9
Thyroid cartilage	-	-	-	-	11	100%	3	5%	11
Cricoid cartilage	-	-	-	-	1	100%	1	2%	1
Extralaryn. i.	-	-	-	-	7	100%	0	0%	7
Vocal cord mobility	52	90%	0	0%	-	-	-	-	-

VLS: Videolaryngostroboscopy; CT: Computed tomography; FP: False Positive; Tm: Tumor; Aryepig. Pl.: Aryepiglottic plica; Ant. comm.: Anterior commissure; Subglot. Ar.: Subglottic Area; Postcric. Ar.: Postcricoid Area; Preepig. Ar.: Preepiglottic Area; Paragl. Ar.: Paraglottic Area; Extralaryn. i.: Extralaryngeal invasion.



a b c

FIGURE 1: Left-sided supraglottic larynx cancer.
a) Preoperative fiberoptic laryngeal examination. (Laryngeal face of the epiglottis and ventricular band are involved with the tumor. However, due to the mass of the midline tumor, there was insufficient data regarding the anterior commissure, cord involvement and subglottic expansion).
b) Preoperative computed tomography scan (Tumoral invasion of the left paraglottic area and anterior commissure is visible).
c) Operation specimen (Involvement of the laryngeal face of the epiglottis, ventricular band, vocal cord and anterior commissure, and subglottic invasion are visible)
(See for colored form http://tipbilimleri.turkiyeklinikleri.com/)

A 90-degree rigid laryngeal endoscope (Karl Storz, 8704 SJ), flexible fiberoptic endoscope (Explorent, 800662), laryngostroboscope (Karl Storz, 8010 B), CCD color video camera (Karl Storz, Endovision 2010 PAL), SVHS video recorder (Panasonic AG 7350), color monitor (Sony, Black Trinitron), and color videoprinter (Bosch Bauer, CVP 110) were used during the study.

CT was performed with an 8-row detector scanner (Lightspeed, GE, Milwaukee, Wisconsin, USA). Axial slices of 3.75 mm thickness and 1 mm interspace were obtained from the base of the tongue to the trachea after intravenous administration of 80 mL nonionic contrast material (Omnipaque 100 mL/350 mg, Nycomed, Norway).

DETERMINATION OF LARYNX CANCER BY CT

There are some anatomical key points to determine laryngeal structures radiologically. The true vocal cords lie at the upper margin of the cricoid cartilage (at the level of the anteriorly pointing vocal processes of the arytenoid cartilages). The anterior commissure is visible between the anterior junction of the two vocal cords where soft tissue should be only 1-2 mm thick. Thickening of the anterior commissure was used as a sign for involvement of this region.

The subglottic region has a characteristic appearance where the cricoid cartilage is visible as a complete ring providing the foundation of the laryngeal skeleton. Any soft tissue at the subglottic level is abnormal. The presence of an enlarged delphian node anterior to the trachea also indicates subglottic involvement. Thus, presence of soft tissue at the subglottic level, an irregular tickening of cricothyroid membrane and an enlarged delphian node were used to determine subglottic involvement.

The fatty C-shaped preepiglottic space is bounded anteriorly by the thyroid cartilage and thyrohyoid membrane and posteriorly by the epiglottis and quadrangular membrane. The fat and connective tissue within the paraglottic space is confined by the thyroid cartilage and cricothyroid membrane anterolaterally, inferomedially by the conus elasticus, superomedially by the ventricular complex (comprising the true cord, false cord and the intervening ventricle) or vestibule, and posteriorly by piriform sinus. Widening of the preepiglottic and paraglottic spaces by tumor and replacement of fat by tumor tissue were used as signs of involvement of these regions. Erosion of the thyroid cartilage and cricoid cartilage indicated cartilage involvement by the tumor. Sclerosis was used as an indicator of involvement for arytenoid or cricoid cartilages.

DETERMINATION OF LARYNX CANCER BY ENDOSCOPY

Endoscopic evaluation allows one to determine the lesions that have infiltrated mucosal surfaces. According to anatomical localization (12 anatomical areas) of tumoral invasion in the larynx, the in-

volvement of each region was noted. Submucal involvements of the tumor and distal part of the larynx in bulky tumors could not be evaluated. In addition, it was impossible to evaluate paraglottic and preepiglottic spaces, cricoid and thyroid cartilage involvement, and extralaryngeal invasion directly by endoscopy.

RESULTS

It was not possible to evaluate the paraglottic area and preepiglottic area directly by endoscopy. Subglottic extension of the tumor was identified in 87% by CT and 25% by VLS. Larynx CT was more effective than VLS in the evaluation of the paraglottic area, preepiglottic area, and subglottic area (Table 1). Preepiglottic and paraglottic area involvements were identified in 90% and 79% with CT, respectively. There were false positive results in 5 patients (8%) with CT related to the subglottic region. Although the direct identification of tumoral involvement in the paraglottic and preepiglottic areas by VLS was not possible, it was possible to obtain a sense of the involvement in these areas by observing the localization of the tumor (i.e., epiglottic involvement may indicate preepiglottic area invasion and ventricule involvement may be a sign of paraglottic invasion) and vocal cord mobility (i.e., vocal cord fixation may be a sign of paraglottic area involvement). We did not use this information for positive involvement as these data do not accurately show tumor involvement.

Although it was impossible to identify cartilage involvement and the presence of extralaryngeal invasion directly by VLS, anterior commissure invasion, the presence of subglottic involvement, large tumors and fixation of the vocal cord and arytenoids may be the signs. All patients (n= 11) with thyroid cartilage invasion and 1 patient with cricoid cartilage invasion were identified by CT. Extralaryngeal invasion was identified 100% by CT. Thus, CT was superior to VLS to identify the involvement of the thyroid, cricoid cartilages, and extralaryngeal invasion. However, there were 3 false positives (5%) related with thyroid cartilage invasion and 1 false positive result related with cricoid cartilage invasion with CT.

Vocal cord involvement was identified correctly in 87% and 62% by VLS and CT, respectively. There were 5 false positive results (8%) with CT. Anterior commissure involvement was frequently identified (79%) with endoscopy; the highest false positive result with CT (12%) was in this region. Hence, VLS was more effective than CT for the evaluation of vocal cords and anterior commissure.

Aryepiglottic plicae were another area identified more effectively by VLS than CT. Aryepiglottic plicae involvement was identified in 93% and 73% by VLS and CT, respectively. The false positivity rate was 10% with CT.

Both diagnostic methods were effective for identification of tumor on the epiglottis. The least successful area for detection of tumoral invasion with both methods was the ventricle. Of 30 patients with ventricle involvement, 6 (20%) were identified by VLS, and 9 (30%) by CT.

Due to a bulky supraglottic tumor limiting the visualization of the vocal cords and lack of patient cooperation, vocal cord and arytenoid movements could be assessed in only 52 of 58 patients (90%).

DISCUSSION

Correct preoperative staging of larynx cancers plays an important role in treatment planning and choosing the appropriate surgical technique. Today, better understanding of a tumor's invasion pattern and its clinical and biological behavior encourages head-neck surgeons to choose partial surgical techniques.[3] Diagnostic methods such as VLS, CT, and magnetic resonance imaging (MRI) enable more accurate identification of tumor borders at the anatomic subunit level. MRI is most frequently used if there is uncertainty in assessing cartilage involvement when this is critical for therapeutic decisions. It may also better define the margin between the tumor and thyroarytenoid muscle and involvement of the tongue base.[9] In recent years, ultrasound and fluorodeoxyglucose (FDG) positron emission tomography (PET) have been other methods used for the evaluation of larynx. Although ultrasound may be used to visualize the anterior laryngeal structures, it is not sufficient for adequate

primary tumor staging.[10] FDG-PET is more useful for the detection of recurrent tumors and in distinguishing recurrent tumors from post-radiotherapy changes rather than evaluating the primary tumour.[11] Positive PET scan findings should be assessed with biopsy and follow up PET imaging if this is negative. Hence, due to different evaluation methods, clinical practice of partial surgical techniques has expanded, providing many more patients a life without permanent stoma and loss of phonation.

VLS enables evaluation of vocal cord mobility. Hence, cord fixation, which is an important criterion to determine the indication for partial surgical techniques, can be evaluated. Large and clear images can be obtained by VLS. Laryngeal lesions can be evaluated from different angles by using a rigid or flexible telescope in cases where the epiglottis is located low. Laryngeal lesion can be reexamined and in a more detailed way when necessary through a video recording process used during the VLS examination. This method provides the opportunity to determine lesions that are not very clear and difficult to visualize during indirect laryngoscopy.[4,6,12-14] Studies assessing the effectiveness of VLS in laryngial pathologies report that the diagnosis made by indirect laryngoscopy changes in 10% to 43% of cases after VLS evaluation.[4,7,8,12] Glottic closure, mucosal vibration of vocal cords, and nonvibratory segments can be evaluated by VLS. By enabling the determination of early stage larynx tumors, this method provides the chance for treatment with laser cordectomy or radiotherapy. Flexible fiberoptic endoscopes are advantageous for diagnosis in adult patients who have a strong glossopharyngeal reflex, a supraglottic mass or an epiglottis with an omega shape.

CT has some advantages. It gives the opportunity to assess laryngeal cartilages and extralarygeal invasion, enables examination of paraglottic and preepiglottic areas that cannot be examined directly by VLS and shows subglottic invasion more clearly than VLS.[9] However, it is not possible to determine vocal cord mobility by CT. VLS provides the opportunity to visualize the lesion directly. Furthermore, by means of stroboscopic examination, mucosal vibration can be examined and early stage larynx cancers can be determined. This provides the possibility to cure the disease with a more limited surgery such as laser chordectomy or radiotherapy. The first point to consider when deciding on total or partial surgery in larynx cancers is to see if the location of the tumor is glottic or supraglottic. Sinus priformis, anterior commissure, ventricle, arytenoid involvement, subglottic invasion, and cricoid cartilage involvement are important anatomic guidance points for choosing a partial surgical technique. If supraglottic horizontal laryngectomy (SHL) is considered for supraglottic tumors, invasion of sinus priformis and ventricle changes the surgical method. If the upper part of the sinus priformis is the only area invaded by tumour, extended SHL can be performed. Otherwise, invasion of the sinus priformis is required for laryngopharyngectomy. In this study, sinus priformis involvement was 81% with VLS but 90% with CT. In early stage tumors located on the medial wall of sinus priformis, clearer images with VLS lead to more correct staging. However, CT is superior for the determination of apex lesions.

Invasion of the ventricle basis in supraglottic tumors leads to the need for supracricoid laryngectomy. Despite a low success rate in the determination of ventricle involvement with both CT and VLS in the study, CT was more successful compared with VLS, with a 60% detection rate. The anatomic subunit in which VLS yielded the highest false positive rate (5%) was this area. CT should be used when paraglottic area involvement is suspected in supraglottic tumors with ventricle invasion.

Cricohyoidopexy should be the surgical method of choice in supraglottic tumors in cases of anterior commissure involvement or tumor invasion in vocal cords. Frontoanterior laryngectomy or horizontal glottectomy should be used for glottic tumors where there is anterior commissure involvement. Anterior commissure involvement eases infiltration of the tumor into the thyroid cartilage anteriorly and invasion to the subglottic area inferiorly. Extralaryngeal invasion is common in this area. In the study, VLS was superior to CT for detecting vocal cord and anterior commissure in-

volvement at rates of 87% and 79%, respectively. Another important advantage of VLS is to ensure the visualization of vocal cord and arytenoid mobility. The highest false positivity rate (12%) with CT was in the anterior commissure region. VLS was superior to CT for the assessment of vocal cords, aryepiglottic plicas and anterior commissure. However, evaluation of vocal cords and anterior commissure with VLS may not be possible due to bulky supraglottic tumors. Examination with a 70-degree telescope may be helpful in such cases. CT findings can also be helpful. However, for bulky supraglottic tumors, there may be false positive results, as the tumor can extend to the level of vocal cords or even into the subglottic area because of its mass. The most appropriate way to evaluate these cases is to use a combination of VLS and CT findings.

Preepiglottic area invasion was seen in the majority of the supraglottic cancers at the infrahyoid level.[2,15] Although in most cases epiglottic tumors can be easily determined, it is not possible to detect preepiglottic area invasion by VLS. Preepiglottic area involvement in supraglottic tumors can only be determined by CT and MRI. Detection of preepiglottic area involvement is not particularly important in the choice of the operation because every supraglottic tumor invades the preepiglottic area.[15] That is why the preepiglottic area should be included in the surgical specimen when performing SHL. From this point of view, CT is not necessary for tumors that have not invaded the ventricle inferiorly as seen during VLS examination. However, CT must be performed to determine the level of preepiglottic space invasion for small infrahyoid epiglottic tumors planned to undergo laser operation.[8,15,16] Preepiglottic area involvement was 90% with CT in our study.

For glottic tumors, if vocal cord tumors invade the arytenoids, vertical laryngectomy is performed. Arytenoid involvement can be determined by both diagnostic methods. Invasion of arytenoid cartilage and surface mucosa should be evaluated in a different manner. CT can show both mucosal involvement and cartilage invasion. However, microscopic invasion of tumors into the cartilage cannot be determined with CT.[1,5] Most of the time, invasion of either of them prompts the need for resection of arytenoid cartilage. That is why there is no need to use CT to determine the cartilage involvement if tumoral infiltration has been detected on the mucosa that covers the arytenoid by VLS. VLS was superior to CT for the detection of tumoral involvement of the arytenoids. All cases of involvement of the arytenoids were detected by VLS in our study.

As for the glottic tumors, invasion of tumor into the subglottic area more than 1 cm and extralaryngeal invasion are contraindications for partial surgical techniques. It is important to evaluate accurately the tumors that involve the anterior commissure. This is because the anterior commissure is the preferential pathway for cancer extension to the anterior angle of the thyroid cartilage and downward to the subcommissural region and cricothyroid membrane. Involvement of the anterior side of the thyroid cartilage eliminates the indication for vertical partial laryngectomy. Cricoid cartilage invasion results in total laryngectomy. Previous studies showed that CT was superior to VLS in determining the involvement of laryngeal cartilages and extralaryngeal invasion.[5,16,17] It is not possible to determine cartilage involvement by VLS. Thyroid cartilage involvement was determined by CT in all 11 patients.

It is difficult to assess the level of subglottic area invasion in centimeters vertically with VLS. As a result, tumor borders may not be determined correctly. Direct laryngoscopic examination before laryngeal surgery is appropriate to determine subglottic area involvement. CT can be used to determine subglottic involvement.[5,16,17] Eighty-seven percent of the cases with subglottic involvement were correctly diagnosed by CT in this study. However, the subglottic area was the second anatomic subunit in which CT yielded the highest false positive rate (8%). Bulky tumors that extend downward to the subglottic region through the vocal cords were the cause of false positive results related with anterior commissure and the subglottic area. In this study, subglottic invasion was determined in 5 cases (8%) by CT; however, there was no invasion in any of these cases by histopathology.

In light of the results gathered from our study and the literature review, we can suggest that vocal cords, aryepiglottic plicae, and anterior commissure involvement are evaluated more clearly by VLS and laryngeal cartilage involvement, extralaryngeal invasion, and paraglottic, preepiglottic and subglottic areas can be better assessed by CT. However, considering the necessity to evaluate the extension of the tumor, its mass effect, and vocal cord mobility, both methods need to be employed according to tumor localization for accurate staging. Otherwise, assessment done only by VLS may result in an incomplete resection of the tumor and undertreatment. On the other hand, assessment done only with CT may result in overtreatment. This means functional loss due to an unnecessary large excision in tumors that could instead be handled by limited surgical resection. Zbaren et al. reached a 57.5% correct staging rate by indirect laryngoscopy (IL) and VLS in a study they performed on 40 patients. The rate reached 80% when they combined CT with IL and VLS.[5] Charlin and colleagues reported that tumor stage was higher in 22.7% of the cases when they supported their clinical and endoscopic examination findings with CT in their series of 66 patients.[1]

CONCLUSION

It is necessary to determine anterior commissure invasion, cartilage invasion, subglottic invasion, invasion into preepiglottic and paraglottic spaces, and extralaryngeal invasion for the correct staging of tumors in patients with larynx cancer. Borders of the laryngeal lesion can be well assessed by VLS because this method provides a large and clear image and enables reexamination by watching the recording in slow motion. Use of different angled endoscopes and fiberoptic endoscopes increases the effectiveness of VLS when assessing the areas that are important for staging and helps to assess difficult areas such as the anterior commissure, sinus priformis, and subglottic area. CT is superior to VLS for assessment of the subglottic area, laryngeal cartilages, preepiglottic area, and paraglottic areas. The advantage of VLS over CT is that it enables visualization of the vocal cords and arytenoid mobility as well as mucosal vibrations of the vocal cords. In this study, VLS was more effective for the assessment of anterior commissure, vocal cords and arytenoids, and CT was more effective for the evaluation of the ventricle, preepiglottic area, thyroid-cricoid cartilage invasion, and extralarygeal invasion.

As a result, VLS and CT are complementary to each other for correct staging of patients with larynx cancer. It is possible to stage the disease accurately and apply the appropriate treatment by using the previously mentioned diagnostic methods cooperatively according to the location of the tumor.

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