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Evaluation of Vocal Cord FDG Uptake on PET/CT Using Neck MRI

PET/BT'de Vokal Kord FDG Tutulumunun Boyun MRG ile Değerlendirilmesi

Elif Aktas[1], Erkan Bilgin[1], Ali Sahin[1], Ezel Yaltirik Bilgin[1], Felat Toprak[2], Gulin Ucmak[3]

[1]Department of Radiology, Ankara Dr. AY Oncology Training and Research Hospital, Ankara, Turkiye
[2]Department of Otolaryngology, Ankara Dr. AY Oncology Training and Research Hospital, Ankara, Turkiye
[3] Department of Nuclear Medicine, Ankara Dr. AY Oncology Training and Research Hospital, Ankara, Turkiye

Abstract

Aims: Elevated fluorodeoxyglucose (FDG) uptake in the vocal cords observed on PET/CT scans may result from tumors, vocal cord paralysis, inflammation, or normal phonatory activity. Therefore, neck MRI is valuable for assessing the anatomical correlates underlying these metabolic changes in clinical practice.

Material and Method: A retrospective cross-sectional study was performed involving patients with elevated FDG uptake in the vocal cords on PET/CT scans from 2020 to 2025. Patients with head and neck cancers or MRI scans with artifacts were excluded. Neck MRI results from 38 PET-positive patients were compared with those of a control group of 17 individuals without vocal cord uptake. The apparent diffusion coefficient (ADC) was measured for both vocal cords, and vocal cord-to-muscle signal intensity ratios were calculated on T1- and T2-weighted images. Demographic, clinical, and imaging data were analyzed using appropriate statistical tests.

Results: The study included 38 patients and 17 controls. No significant differences were observed between the groups in SUVmax, ADC, or T1/T2 signal intensity ratios. No strong associations were identified between underlying conditions, sex, MRI findings, or history of chemotherapy or radiotherapy and the imaging parameters. However, age demonstrated a moderate positive correlation with ADC values in the right vocal cord and a weak-to-moderate correlation in the left vocal cord.

Conclusion: Increased FDG uptake in the vocal cords on PET/CT cannot be reliably identified using quantitative MRI measurements alone. These data indicate that comprehensive anatomical assessment, clinical evaluation, and endoscopic examination, when indicated, are necessary for interpreting vocal cord FDG uptake rather than relying solely on MRI metrics.

Keywords: FDG PET/CT, vocal cord, vocal cord paralysis, neck MRI, apparent diffusion coefficient

Öz

Amaç: PET/BT incelemelerinde vokal kordlarda izlenen artmış florodeoksiglukoz (FDG) tutulumu tümör, vokal kord paralizisi, inflamasyon veya fizyolojik fonatuvar aktiviteye bağlı olabilir. Bu nedenle boyun MRG, klinik pratikte bu metabolik değişikliklerin anatomik karşılığını değerlendirmek açısından değerlidir.

Gereç ve Yöntem: Bu retrospektif kesitsel çalışmada, 2020-2025 yılları arasında PET/BT incelemelerinde vokal kordlarda artmış FDG tutulumu saptanan hastalar değerlendirildi. Baş-boyun kanseri olan hastalar ve artefaktlı MRG incelemeleri dışlandı. Otuz sekiz PET-pozitif hastanın boyun MRG bulguları, vokal kord tutulumu olmayan 17 kişilik kontrol grubu ile karşılaştırıldı. Her iki vokal kord için görünür difüzyon katsayısı (ADC) ölçüldü ve T1- ve T2-ağırlıklı görüntülerde vokal kord-kas sinyal intensite oranları hesaplandı. Demografik, klinik ve görüntüleme verileri uygun istatistiksel testlerle analiz edildi.

Bulgular: Çalışmaya 38 hasta ve 17 kontrol hastası dahil edildi. Gruplar arasında SUVmax, ADC veya T1/T2 sinyal intensite oranları açısından anlamlı fark saptanmadı. Altta yatan hastalık, cinsiyet, MRG bulguları veya kemoterapi/radyoterapi öyküsü ile görüntüleme parametreleri arasında güçlü bir ilişki izlenmedi. Bununla birlikte yaş, sağ vokal kord ADC değerleri ile orta düzeyde, sol vokal kord ADC değerleri ile zayıf-orta düzeyde pozitif korelasyon gösterdi.

Sonuç: PET/BT'de vokal kordlarda artmış FDG tutulumu yalnızca kantitatif MRG ölçümleri ile güvenilir biçimde ayırt edilemeyebilir. Bu veriler, vokal kord FDG tutulumunun yorumlanmasında yalnızca MRG bulgularına dayanmak yerine kapsamlı anatomik değerlendirme, klinik değerlendirme ve gerektiğinde endoskopik incelemenin gerekli olduğunu göstermektedir.

Anahtar Kelimeler: FDG PET/BT, vokal kord , vokal kord paralizisi, boyun MRG, apparent diffusion coefficient

Corresponding *(İletişim)*: Elif Aktaş, Department of Radiology, Ankara Dr. AY Oncology Training and Research Hospital, Ankara, Turkiye
E-mail *(E-posta)*: elifaktasmd@gmail.com
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INTRODUCTION

The larynx is a complex midline organ located between the pharynx and trachea. It maintains airway continuity and contributes to phonation and swallowing. Its basic framework consists of the epiglottic, thyroid, cricoid, and arytenoid cartilages; compartments such as the true vocal cords, ventricle, paraglottic space, and pre-epiglottic space provide a critical anatomico-radiological framework for understanding the spread of laryngeal disease.[1,2] From the perspective of cross-sectional imaging, knowledge of this anatomy is essential, particularly for evaluating submucosal extension, cartilage invasion, and deep soft-tissue compartments; although endoscopy demonstrates the mucosal surface well, it has limited ability to assess deep extension.[1,3]

Magnetic resonance imaging of the larynx provides complementary value to CT, particularly because of its high soft-tissue contrast, in demonstrating the paraglottic space, pre-epiglottic space, submucosal tumor spread, and cartilage involvement. Standard examinations include axial and sagittal T1-weighted images, fat-suppressed T2-weighted images, diffusion-weighted imaging, and post-contrast fat-suppressed T1-weighted sequences; planning the sections parallel to the true vocal cords facilitates anatomical interpretation.[2,4] Nevertheless, laryngeal MRI is susceptible to motion and susceptibility artifacts. Swallowing, coughing, involuntary head and neck movements, and magnetic field inhomogeneities at air-soft tissue interfaces may lead to blurring, ghosting, and distortion. Therefore, instructing the patient not to swallow during the examination, using an appropriate coil, and applying short/optimized sequence protocols are decisive for diagnostic image quality.[4-6]

FDG PET/CT is an important tool in head and neck oncology for evaluating the primary tumor, nodal disease, and distant metastasis; however, increased FDG uptake in the larynx does not always indicate primary malignancy. Under normal conditions, laryngeal FDG activity is generally low and symmetric; in contrast, bilateral physiological increase may occur with phonation or compensatory muscular activity, whereas asymmetry in the uptake pattern may be seen in recurrent laryngeal nerve paralysis.[7-9] Benign causes include vocal cord paralysis, Teflon granuloma, Reinke edema, inflammation, and changes related to surgery and radiotherapy; these conditions may mimic laryngeal malignancy and cause false-positive interpretations.[7,9,10] Conversely, CT findings favoring paralysis should be carefully sought on PET/CT. Findings such as paramedian position of the vocal cord, dilatation of the piriform sinus, and enlargement of the laryngeal ventricle play a key role in interpreting metabolic asymmetry, and the underlying lesion should be investigated along the course of the vagus/recurrent laryngeal nerve from the skull base to the mediastinum; at this point, MRI may be complementary, particularly in the evaluation of the skull base and neck soft tissues.[11-15]

False or equivocal FDG uptake on PET/CT is not unique to the larynx; similar interpretative difficulties in other anatomical regions may also affect the diagnostic process. In the abdomen and pelvis, physiological FDG distribution may vary throughout the stomach, small bowel, and colon; intestinal peristalsis, mucosal activity, lymphoid tissue, and bacterial activity may produce diffuse, multifocal, or nodular appearances. Metformin use is particularly associated with markedly increased colonic uptake and may mimic malignancy.[16] Similarly, muscular activity, injection artifacts, patient motion, metallic material, and attenuation-correction errors may also result in false-positive or false-negative PET/CT interpretations.[7,16] Therefore, the clinical significance of a metabolic focus should not be assessed solely by SUV; it should be evaluated in conjunction with accompanying anatomical imaging, clinical context, and, when necessary, second-line confirmatory examinations.[16]

In light of this information, investigating the additional diagnostic contribution of neck MRI in cases with FDG uptake in the vocal cords on PET/CT appears clinically relevant. The aim of this study was to retrospectively evaluate the correlation between vocal cord FDG uptake detected on PET/CT and neck MRI findings; to determine the relationship of these uptake patterns with underlying structural causes, particularly vocal cord paralysis, benign laryngeal lesions, and possible malignant etiologies; and to identify the circumstances in which MRI provides additional diagnostic value.

MATERIAL AND METHOD

Study Design and Ethical Approval

This retrospective cross-sectional study was approved by the local institutional ethics committee (Decision No: 2025-12/187) and was conducted in accordance with institutional guidelines and the principles of the Declaration of Helsinki.

Study Population

Between 2020 and 2025, 60 cases that underwent FDG PET/CT at our hospital and whose reports described increased FDG uptake at the level of the vocal cords were re-evaluated. Patients were assigned to the PET-positive group based on the original PET/CT reports. In these reports, vocal cord FDG uptake had been evaluated by experienced nuclear medicine physicians using both visual assessment and SUV-based parameters. Increased vocal cord FDG uptake was defined as focal or asymmetric FDG activity at the level of the vocal cords as described in the original PET/CT report. Twenty cases with head and neck tumors were excluded from the study. Neck MR images of the remaining 40 cases were reviewed; two cases were excluded because of marked artifacts, and 38 patients with increased uptake at the level of the vocal cords on PET/CT constituted the study group. The mean interval between PET/CT and neck MRI examinations was 9.56 ± 2.87 days, with a median of 9 days and a range of 5–15 days.

For comparison, 17 oncology patients from the same period who had no vocal cord uptake on PET/CT and had available neck MRI examinations were included in the control group. Thus, a total of 55 cases were included in the study. In all cases, the vocal cords were evaluated morphologically; ADC values and T1 and T2 signal intensities were measured in the right and left vocal cords, and these values were normalized to paravertebral muscle intensity.

Inclusion and Exclusion Criteria

The inclusion criteria were being 18 years of age or older, being an oncology patient, having increased FDG uptake at the level of the vocal cords on PET/CT, or, for the control group, having no vocal cord uptake on PET/CT, having a neck MRI examination from the same period, and having sufficient image quality.

The exclusion criteria were age below 18 years, the presence of a head and neck tumor, prior radiotherapy to the head and neck region, and MRI examinations of insufficient diagnostic quality because of marked artifacts.

MRI Acquisition Protocol

All MRI examinations were performed on a 1.5 Tesla scanner (Signa Excite, GE Medical Systems). The neck MRI protocol included axial and sagittal T1- and T2-weighted images, axial fat-suppressed T2-weighted sections, coronal STIR images, post-contrast fat-suppressed T1-weighted images, and diffusion-weighted imaging (DWI; b = 1000). Diffusion-weighted images were transferred to an independent workstation (Advantage Workstation 3.1, GE Medical Systems) to generate ADC maps.

For quantitative measurements, regions of interest (ROIs) were defined on the vocal cord and in the normal paravertebral muscle planes. ADC measurements were obtained separately from both vocal cords and from the reference muscle plane. In addition, right and left vocal cord signal intensities were measured from non-fat-suppressed unenhanced T1-weighted images and fat-suppressed T2-weighted images, and ratios were calculated using paravertebral muscle intensity.

Imaging Analysis

All image analyses were performed independently by two radiologists with 5 and 23 years of experience, respectively. Qualitative MRI findings were independently evaluated by two radiologists, while quantitative ROI measurements were performed in consensus to ensure consistent ROI placement at the same anatomical level. Morphological features of the vocal cords were assessed; right and left vocal cord ADC values, right and left vocal cord/paravertebral muscle T1 signal ratios, and right and left vocal cord/paravertebral muscle T2 signal ratios were recorded (**Figure 1**). For quantitative MRI assessment, a single manually placed ROI was used for each vocal cord. ROI size was not fixed and was adjusted according to the anatomical dimensions of the vocal cord on the corresponding axial slice. Care was taken to avoid adjacent air, susceptibility or motion artifacts, and non-target soft-tissue structures. Paravertebral muscle measurements were obtained from visually normal muscle tissue at the same or nearest corresponding axial level. Clinical data, including age, sex, pathological diagnosis, and treatment protocols, were obtained from the hospital information management system.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics software (Version 27, IBM Corp., Armonk, NY, USA). The normality of continuous variables, including age, SUVmax, right and left vocal cord ADC values, and right and left vocal cord/paravertebral muscle T1/T2 signal ratios, was assessed using the Shapiro-Wilk test together with histograms and Q-Q plots. Normally distributed variables were presented as mean ± standard deviation, and non-normally distributed variables were presented as median and interquartile range. Independent-samples t-test and Mann-Whitney U test were used for group comparisons, as appropriate. Categorical variables were expressed as numbers and percentages; comparisons were performed using the chi-square test or Fisher's exact test when appropriate. The relationship between SUVmax and MRI findings was also examined in the PET-positive group. Correlations between quantitative imaging parameters and SUVmax or age were evaluated using Pearson or Spearman correlation analysis, depending on the data distribution. The inter-observer variability of MRI findings was assessed using Kappa (K) statistics (poor, <0; slight, 0.01-0.20; fair, 0.21-0.40; moderate, 0.41-0.60; good, 0.61-0.80; almost perfect, 0.81-0.99). A p-value <0.05 was considered statistically significant.

RESULTS

Demographic Findings

The study group included 38 patients with vocal cord uptake on PET/CT, and the control group included 17 patients without vocal cord uptake. The mean age was 61.16 ± 13.27 years in the study group and 60.06 ± 10.47 years in the control group. The study group included 26 male and 12 female patients, whereas the control group included 13 male and 4 female patients. In the patient group, vocal cord paralysis was detected in two cases, one of which is shown in **Figure 2**. Signal changes compatible with vocal cord edema were observed in three cases, and laryngocele was detected in one case. The laryngocele case also had a history of previous thyroidectomy and secondary vocal cord paralysis. In 33 cases, the vocal cords appeared normal on MRI. The diagnoses of the patient and control groups are presented in **Table 1**. The table summarizes the frequency and percentage distribution of diagnoses among 55 patients included in the final analysis. Lung carcinoma was the most common diagnosis, followed by lymphoma and breast carcinoma.

Table 1. Distribution of primary diagnoses in the study cohort.

Diagnosis	Frequency	Percent
Endometrial carcinoma	2	3.6
Rectal carcinoma	5	9.1
Bladder carcinoma	3	5.5
Breast carcinoma	7	12.7
Lung carcinoma	22	40.0
Multiple myeloma	1	1.8
Leukemia	2	3.6
Germ cell tumor	1	1.8
Prostate carcinoma	4	7.3
Lymphoma	8	14.5
Total	55	100.0

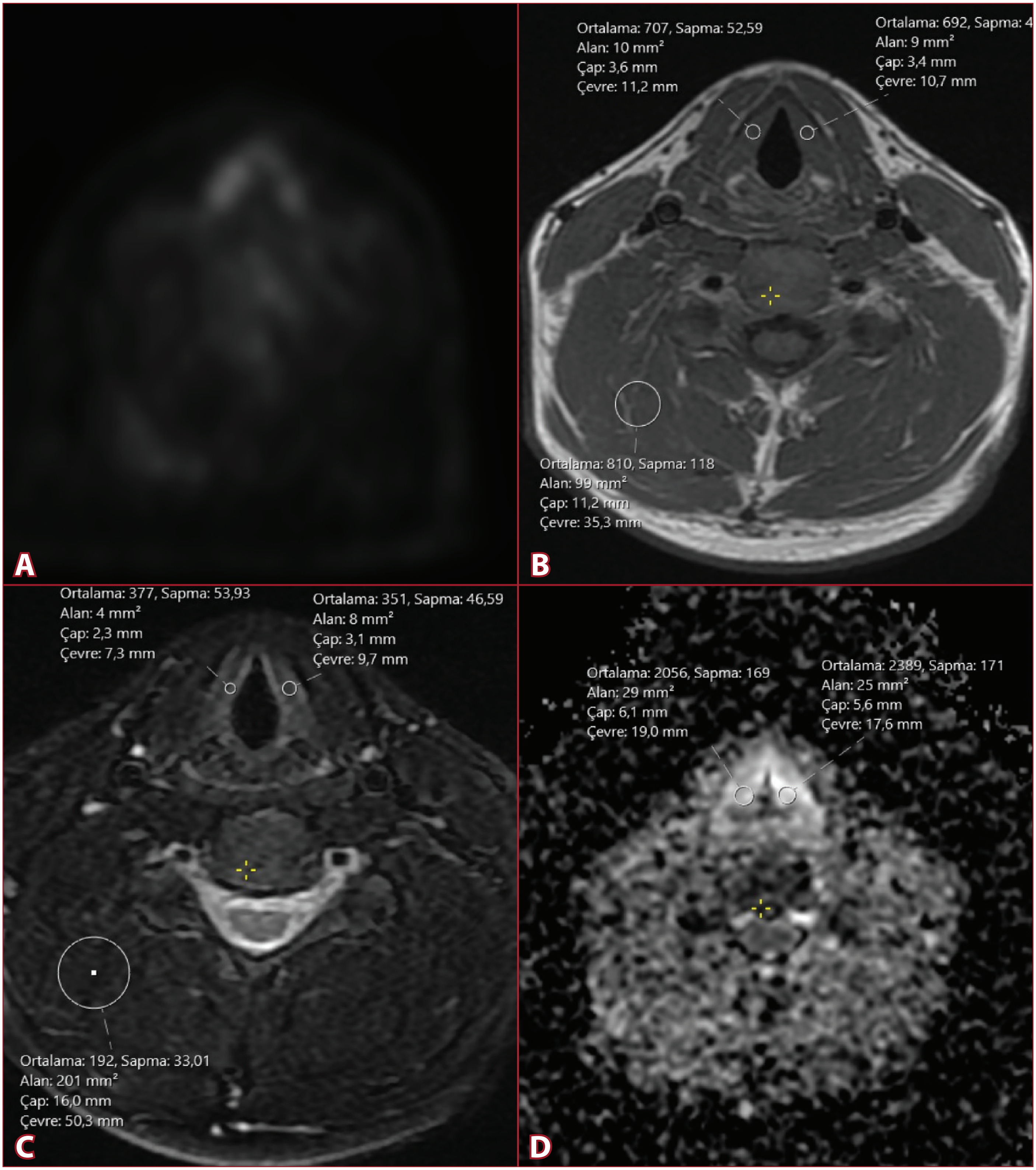

Figure 1. A 35-year-old patient followed with a diagnosis of germ cell tumor showed uptake at the level of the vocal cord on PET imaging. (A) PET image demonstrates focal FDG uptake at the vocal cord level. (B-C) Axial T1-weighted and fat-suppressed T2-weighted images show no pathological signal alteration in the vocal cord. ROI measurements obtained from the vocal cord and paravertebral muscle planes are shown. (D) ADC map demonstrates measurements obtained at the level of the vocal cord.

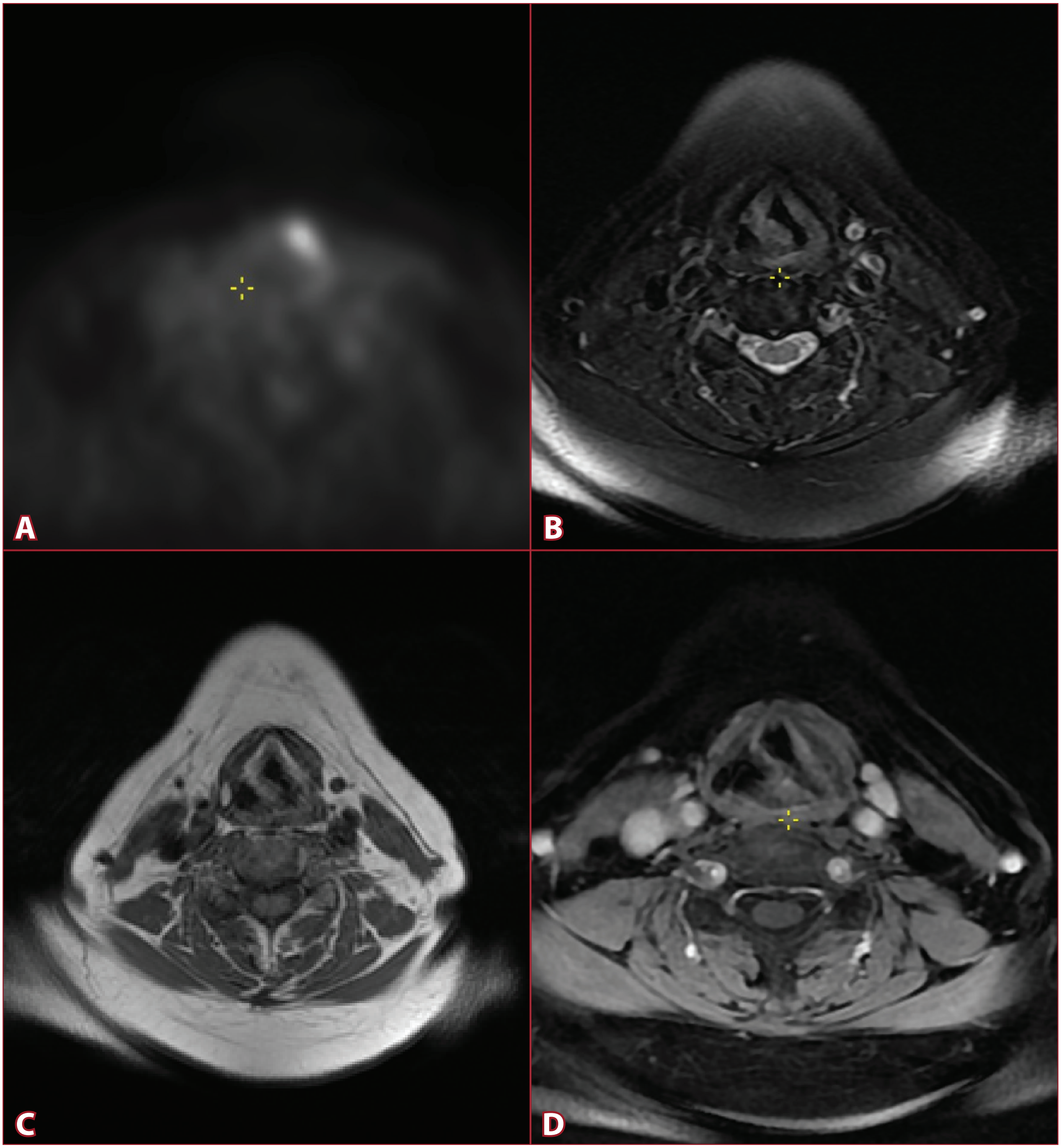

Figure 2. A 66-year-old patient followed for breast cancer showed uptake at the level of the left vocal cord on PET imaging. (A) PET image demonstrates focal FDG uptake at the vocal cord level. (B-C) Axial T1-weighted and fat-suppressed T2-weighted images demonstrated medialization of the right vocal cord, thickening of the aryepiglottic fold, and dilatation of the piriform sinus; these findings were interpreted as consistent with right vocal cord paralysis. (D) Axial fat-suppressed post-contrast T1-weighted image showed no evident contrast enhancement.

Comparison of Quantitative Imaging Parameters

When SUVmax values and MRI-based quantitative measurements were compared between the patient group with vocal cord uptake on PET/CT and the control group, no statistically significant differences were detected in any parameter (**Figure 3**). Similarly, no significant differences were observed between the underlying disease diagnosis and SUVmax values or MRI measurements.

Correlation Analyses

A moderate positive correlation was detected between age and right vocal cord ADC values (Spearman rho approximately 0.44, p approximately 0.0007, p approximately 0.005 after FDR correction). A weak-to-moderate positive correlation was found between age and left vocal cord ADC values (Spearman rho approximately 0.33, p approximately 0.0126, p approximately 0.044 after FDR correction). These findings indicate that, in the current dataset, ADC values tended to increase in both vocal cords with increasing age (**Figure 4**). In contrast, no significant relationship was detected after FDR correction between age and right T1, left T1, right T2, left T2, or SUVmax values.

Associations with Clinical and MRI Findings

No significant association was observed between sex and MRI measurements or SUVmax. Similarly, no statistically significant association was found between the presence or absence of MRI findings and SUVmax, ADC, T1, or T2 measurements. Inter-observer agreement was good to near perfect (K value 0.622-0.888). No significant differences were detected in these quantitative parameters when patients were stratified according to chemotherapy status or radiotherapy history, provided that radiotherapy involving the head and neck region was excluded.

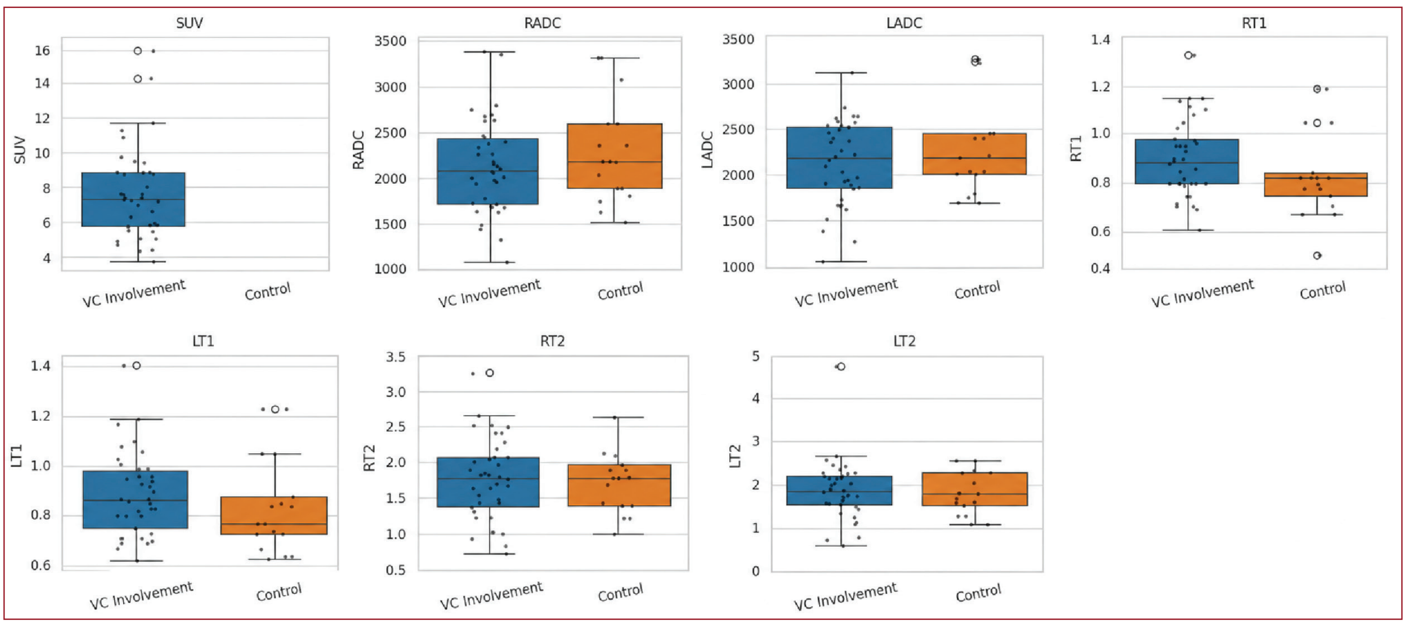

Figure 3. Comparison of PET/MRI-derived parameters between patients with vocal cord involvement and controls. Box-and-whisker plots show the distribution of SUV, RADC, LADC, RT1, LT1, RT2, and LT2 values in the VC involvement and control groups. The central line represents the median, boxes indicate the interquartile range, whiskers show the data range excluding outliers, and individual dots represent patient-level measurements.

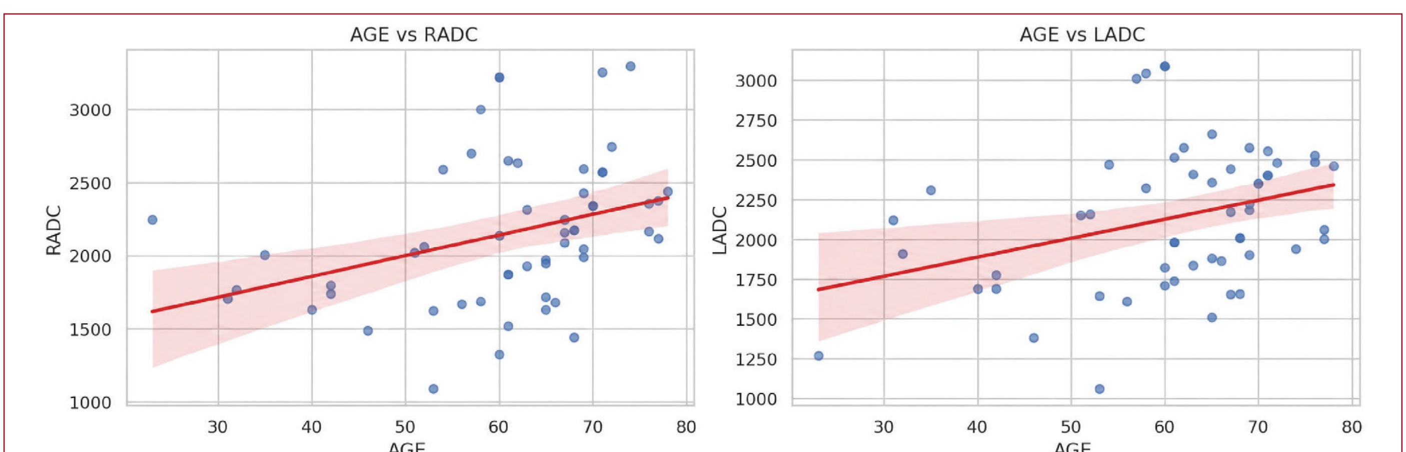

Figure 4. Relationship between age and ADC-derived parameters. Scatter plots show the association of age with RADC and LADC values. Each point represents an individual patient. The red line indicates the fitted linear regression trend, and the shaded area represents the 95% confidence interval. Both RADC and LADC show a positive trend with increasing age.

DISCUSSION

In this study, neck MRI findings were retrospectively evaluated in patients with increased FDG uptake at the level of the vocal cords on PET/CT, and the relationship between quantitative MRI parameters and PET findings was investigated. Our main finding was that there was no significant difference between patients with vocal cord uptake and the control group in terms of SUVmax, ADC, or T1/T2 signal ratios. This result suggests that vocal cord FDG uptake observed on PET/CT may not have a distinct structural or quantitative MRI correlate on its own, and therefore, metabolic findings should be interpreted within the anatomical and clinical context.

Increased FDG uptake at the level of the vocal cords is a well-known diagnostic pitfall in head and neck PET/CT interpretation. The literature emphasizes that normal laryngeal FDG activity is generally low and symmetric, whereas phonation, inflammation, post-surgical changes, Reinke edema, and particularly recurrent laryngeal nerve paralysis may cause asymmetric or increased uptake patterns. In our study, the inability of quantitative MRI measurements to significantly distinguish PET-positive cases supports the possibility that benign or secondary mechanisms may play a role in a substantial proportion of cases of vocal cord FDG uptake.[7,9,17-19]

There are several case reports in the literature regarding vocal cord uptake on PET/CT. The article by Erdogan et al. presents a case report examining how Reinke edema, a benign laryngeal lesion, may produce misleading findings on PET/CT imaging. This imaging method, which is normally used in cancer diagnosis, demonstrated high metabolic activity in that case and raised suspicion of laryngeal cancer. However, histopathological examinations showed that this intense uptake was not due to a malignant tumor but to fluid accumulation and vascular changes in the vocal cords.[9]

Saad et al. discussed the causes of PET/CT uptake in three cases showing vocal cord uptake: one with vocal cord paralysis, one with glottitis due to chronic cough, and one diagnosed with squamous cell carcinoma of the vocal cord.[19] Numerous cases of false-positive PET/CT findings due to vocal cord paralysis have been described.[19-23] In our series, vocal cord paralysis was identified in two separate patients. One patient showed imaging findings consistent with vocal cord paralysis. In another patient with prostate carcinoma, a laryngocele was observed, and the patient had a history of previous thyroidectomy, which was considered to be associated with secondary vocal cord paralysis. In the literature, false-positive vocal cord uptake secondary to a laryngeal cyst has been reported in a patient followed for follicular thyroid carcinoma.[24]

In the study by Seymour et al., among patients showing vocal cord uptake on PET/CT, 60% were true positives, and 40% were false positives. In true-positive patients, vocal cord paralysis and tumor were detected by laryngoscopy. In false-positive patients, laryngoscopic findings were normal. The main cause of these misleading images was reported to be normal physiological muscular activity, such as swallowing, coughing, or speaking, during the scan.[25]

One notable finding of our study was the positive correlation between age and ADC values of both the right and left vocal cords. This may suggest that age-related microstructural changes in vocal cord tissue can affect water diffusion, leading to a tendency toward increased ADC values. In contrast, the lack of a significant relationship between age and SUVmax or T1/T2 signal ratios may indicate that metabolic activity and conventional signal characteristics are not affected by age to the same extent as ADC. This finding should be confirmed in future studies with larger series and age-matched control groups. No study on normal vocal cord ADC values has been reported in the literature.

The present results are also consistent with the literature on false-positive FDG uptake described in other anatomical regions. In particular, factors such as intestinal peristalsis, mucosal activity, lymphoid tissue, bacterial activity, and metformin use in the abdomen and pelvis are known to cause variable PET/CT uptake patterns that may mimic malignancy. By a similar approach, an isolated FDG increase in the larynx should not be regarded as directly equivalent to malignancy; rather, MRI, endoscopy, clinical symptoms, and structural pathologies along the underlying nerve course should be evaluated together. The findings of this study suggest that neck MRI has a complementary role in demonstrating the underlying anatomical cause, rather than serving solely as a tool to confirm the PET finding through quantitative parameters.[10,16,18]

In our study, no significant associations were observed between sex, the presence of MRI findings, chemotherapy status, or radiotherapy status and SUVmax or MRI measurements. This may indicate, on the one hand, that these parameters truly have limited discriminative value, while, on the other hand, the sample size may have limited statistical power. In particular, the relatively small control group and the retrospective nature of the study may have reduced the sensitivity of detailed subgroup analyses.

This study has several limitations. First, because of its retrospective and single-center design, patient-selection bias could not be completely excluded. Second, the sample size was relatively limited, and the smaller control group may have affected group comparisons. Third, the etiology of vocal cord uptake was not confirmed by a histopathological or laryngoscopic gold standard in every case. Although the interval between PET/CT and neck MRI examinations was relatively short, the examinations were not performed on the same day; therefore, minor interval-related changes in FDG uptake or MRI appearance cannot be completely excluded. Another limitation is that interobserver agreement for qualitative MRI findings was assessed using kappa statistics, quantitative ROI measurements were performed by consensus to ensure consistent ROI placement at the same anatomical level. Therefore, interobserver variability for continuous MRI parameters could not be evaluated using ICC analysis. In addition, MRI measurements may be affected by technical factors, ROI placement, and motion artifacts during the examination. Nevertheless, the combined evaluation of PET/CT and MRI data focusing on the same anatomical region adds value to our study.

CONCLUSION

Increased FDG uptake detected at the level of the vocal cords on PET/CT is not always associated with primary malignancy and may also be related to benign, physiological, or secondary causes. In this study, no significant differences were detected between PET-positive patients and the control group in SUV max, ADC, or T1/T2 signal ratios; in contrast, a positive correlation was observed between age and vocal cord ADC values. Our findings suggest that detailed anatomical assessment, clinical information, and, when necessary, endoscopic correlation are more decisive than quantitative MRI measurements in interpreting vocal cord FDG uptake. In this patient group, neck MRI should be regarded as a complementary method for identifying the underlying structural cause rather than as a direct numerical correlate of the PET findings.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board/Ethics Committee of Ankara Dr. Abdurrahman Yurtaslan Oncology Training and Research Hospital (Decision No: 2025-12/187).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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