

Can Radiologists Accurately Predict Preepiglottic Space Invasion with MR Imaging?

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OBJECTIVE. The purpose of this study was to evaluate whether observers of MR imaging can accurately predict invasion of the preepiglottic fat (PEF) in patients with oropharyngeal and supraglottic laryngeal squamous cell carcinoma.

MATERIALS AND METHODS. For 41 patients with pathologically proven squamous cell carcinoma of the oropharynx and supraglottic larynx, we retrospectively analyzed their MR images for the presence or absence of PEF neoplastic invasion. Unenhanced T1-weighted, fat-suppressed T2-weighted, and contrast-enhanced fat-suppressed T1-weighted scans were analyzed independently by two neuroradiologists who were unaware of the surgical findings. Proof of diagnosis was determined by pathologic analysis, intraoperative assessment, or both.

RESULTS. Sixteen patients had neoplastic infiltration of the PEF. All infiltration was correctly predicted by the two observers of MR imaging, resulting in a sensitivity of 100%. Twenty-five patients had no invasion of the PEF by pathologic or surgical evaluation or both. Of these patients, negative findings were correctly predicted on MR imaging in 21 patients, whereas positive findings were incorrectly predicted on MR imaging in the remaining four patients, resulting in a specificity of 84% and an accuracy of 90%. In two of the four false-positive cases, effacement of the fat in the preepiglottic space by large tumors was mistaken for invasion. In a third patient, spread to the paraglottic space was mistaken for PEF extension. In the fourth false-positive case, glandular tissue along the ventral epiglottis may have been mistaken for tumor. The observers believed that unenhanced sagittal and axial T1-weighted scans were particularly useful because fat saturation artifacts may degrade T2-weighted and contrast-enhanced T1-weighted scans.

CONCLUSION. Unenhanced T1-weighted MR images are highly sensitive for neoplastic infiltration of the preepiglottic space in patients with oropharyngeal and supraglottic laryngeal carcinoma who are at risk for such spread. Identification of PEF invasion is important because it affects prognosis and may affect surgical management.

 On the basis of the cancer facts and figures presented by the American Cancer Society, squamous cell carcinoma of the head and neck was estimated to affect more than 53,000 new patients in 1996. Its treatment is complex, and the need for and type of surgery are guided by the site of origin of the tumor as well as staging at the time of clinical presentation. Staging is determined by several factors: submucosal tumor spread into the deep spaces of the neck, including the preepiglottic, paraglottic, and prevertebral spaces; invasion of the cartilaginous framework that supports the larynx; lymphadenopathy; and distant metastases. Direct visualization combined with endoscopy is sensitive in evalu-

ating the mucosa of the aerodigestive tract [1, 2]. However, neoplastic infiltration of the deep spaces surrounding the larynx may be difficult to detect on physical and endoscopic examination. As a result, patients are clinically understaged frequently [3].

Effective management of cancer of the oropharynx, especially the tongue base, and the supraglottic larynx is crucial in that these structures play vital roles in swallowing and speech. Although CT and MR imaging have provided important diagnostic information in the staging of head and neck cancer (including detection of clinically occult lymphadenopathy and involvement of the laryngeal cartilages), these techniques have met with limited

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success in the evaluation of neoplastic spread to the deep paralaryngeal spaces. Patients with oropharyngeal (base of tongue) and supraglottic laryngeal (epiglottic) carcinomas are at greatest risk for neoplastic spread to the preepiglottic space. On MR imaging the preepiglottic space appears as a triangular, demarcated region anterior to the epiglottis and deep in relation to the hyoid bone, which is readily identified on unenhanced T1-weighted images because of its fat content, which is hyperintense relative to surrounding tissues in the neck (Fig. 1).

Carcinomas of the base of tongue with valvular mucosal involvement may be amenable to resection of the epiglottis with transection of the preepiglottic space as the inferior margin.

whereas deep invasion into the preepiglottic space necessitates a supraglottic or total laryngectomy. When the preepiglottic fat (PEF) is uninvolved, patients may be treated conservatively with local resection or radiation therapy. Epiglottic carcinomas that extend into the PEF frequently necessitate supraglottic laryngectomy, resulting in a change in speech and making swallowing more difficult. Total laryngectomy raises quality of life issues with respect to the patient's ability to swallow and speak.

The improved soft-tissue resolution of MR imaging over CT as well as the multiplanar capabilities of MR imaging make it attractive as a diagnostic tool for early detection of tumor spread into the deep spaces surrounding the larynx. The purpose of this study was to

determine the accuracy of MR imaging in the detection of neoplastic infiltration of the preepiglottic space.

Materials and Methods

Forty-one patients (28 men, 13 women; mean age, 61 years [range, 30–84 years]) with oropharyngeal or supraglottic laryngeal carcinomas seen in a 3-year period (1993–1995) were selected from the database of patients referred to the Head and Neck Cancer Center at our institution for inclusion in this study. All patients had pathologically proven squamous cell carcinomas of the oropharynx (base of tongue or tonsil extending into the base of tongue) (24 cases) or supraglottic larynx (epiglottis or aryepiglottic fold) (17 cases). Sixty patients from the Head and Neck Cancer Center database were

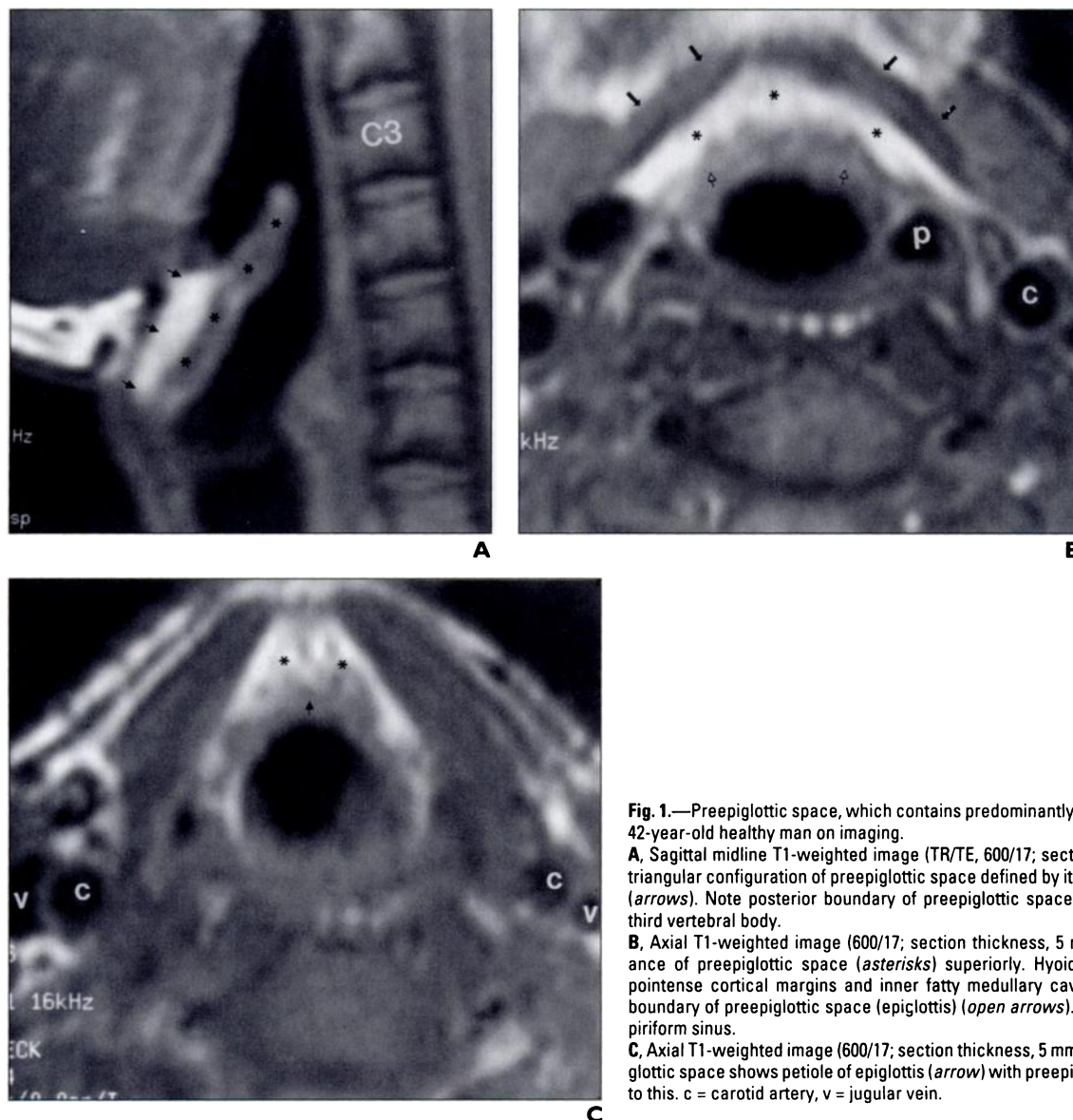


Fig. 1.—Preepiglottic space, which contains predominantly fat, shows normal findings in 42-year-old healthy man on imaging.

A. Sagittal midline T1-weighted image (TR/TE, 600/17; section thickness, 5 mm) reveals triangular configuration of preepiglottic space defined by its hyperintense fatty contents (asterisks). Note posterior boundary of preepiglottic space (epiglottis) (asterisks). C3 = third vertebral body.

B. Axial T1-weighted image (600/17; section thickness, 5 mm) reveals healthy appearance of preepiglottic space (asterisks) superiorly. Hyoid bone is evident by its hypointense cortical margins and inner fatty medullary cavity (arrows). Note posterior boundary of preepiglottic space (epiglottis) (open arrows). c = carotid artery, p = top of piriform sinus.

C. Axial T1-weighted image (600/17; section thickness, 5 mm) at inferior aspect of preepiglottic space shows petiole of epiglottis (arrow) with preepiglottic fat (asterisks) anterior to this. c = carotid artery, v = jugular vein.

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initially identified; however, images of nine patients were omitted from the study because they had treatment at a different institution and no pathologic correlation or clinical follow-up was available. Images of ten other patients were removed from the study because they did not meet inclusion criteria (five had carcinomas of the oral tongue that did not extend to the tongue base; two patients initially interpreted as having supraglottic carcinomas had primary hypopharyngeal carcinomas; and three patients with oropharyngeal cancer had lesions isolated to the soft palate, where the expected growth pattern is not into the preepiglottic space). MR images of all patients were retrospectively analyzed to determine the presence or absence of PEF invasion. Of the 41 patients, none had surgery before MR imaging, and four had previous radiation therapy for unrelated primary head and neck carcinomas 1 year or more before treatment of their new carcinomas.

All examinations were performed on a 1.5-T system (Signa; General Electric Medical Systems, Milwaukee, WI) using an anteroposterior volume neck coil (Medical Advances, Milwaukee, WI). The MR imaging protocol consisted of standard spin-echo sagittal T1-weighted images (TR/TE range, 600/11–17) followed by fat-suppressed axial fast spin-echo T2-weighted (TR range/TE range, 3500–4000/85–90) and axial spin-echo T1-weighted (600/11–17) images. Images of the neck extended from the level of the cavernous sinus to the thoracic inlet. After IV administration of contrast material (0.1 mmol/kg of gadopentetate dimeglumine [Magnevist; Schering, Berlin, Germany]), axial spin-echo T1-weighted images were repeated using the same imaging parameters as those used for the unenhanced scans. Fast spin-echo and contrast-enhanced studies were per-

formed with the application of frequency-selective fat-saturation techniques. Other imaging parameters included a slice thickness of 5 mm, one or two excitations, 24- to 26-cm field of view, and a 256×128 matrix for sagittal and contrast-enhanced T1-weighted images and a 256×192 matrix for axial unenhanced T1-weighted and T2-weighted images.

Retrospective image analysis was performed independently by two neuroradiologists who were unaware of the surgical findings. All MR images were evaluated for the presence or absence of replacement of fat with abnormal soft tissue in the preepiglottic space. On MR imaging the fat within the preepiglottic space appears as a triangular, demarcated region anterior to the epiglottis and deep in relation to the hyoid bone, which, when normal, is readily identified on unenhanced T1-weighted images because of its fat content, which is hyperintense relative to surrounding tissues in the neck (Fig. 1).

Thirty-seven patients were treated with surgery, including supraglottic laryngectomy (11 patients), total laryngectomy (15 patients), and local resection with adjunctive radiation therapy (11 patients). Proof of diagnosis was determined by gross pathologic and histologic examination of the surgical specimens. Specifically, pathologic correlation by histologic evaluation of the preepiglottic space was made in those patients undergoing supraglottic or total laryngectomy (26 patients). In the 11 patients who underwent combined local resection (in which the preepiglottic space is not resected) and radiation therapy, the surgical margins of the resected specimens were completely free of tumor. In the four patients who were not surgical candidates and were treated with radiation therapy alone (patients with

poor underlying medical condition choosing not to have surgery [$n = 2$] or those with lesions not requiring surgery [$n = 2$]), correlation was made with clinical assessment (visualization and digital palpation at direct nasopharyngolaryngoscopy or intraoperative panendoscopy) and biopsies obtained at the time of staging. In addition, comparison was made with 1- to 2-year clinical and MR imaging follow-up in these patients.

The sensitivity, specificity, accuracy, and positive and negative predictive values of MR imaging in predicting preepiglottic neoplastic invasion were determined. Interobserver agreement regarding image interpretation was based on kappa analysis.

Results

The observers agreed in 40 of 41 cases and resolved one case by consensus ($\kappa = .95$). Sixteen patients (eight with oropharyngeal carcinoma, eight with supraglottic carcinoma) had neoplastic infiltration of the PEF (Figs. 2–4). Fourteen of the 16 cases of neoplastic infiltration were proven on histologic evaluation of the preepiglottic space of the laryngectomy specimens. In two cases, the determination of PEF invasion was made on the basis of clinical assessment (gross invasion in both cases by large tumors that were palpable externally at the level of the thyrohyoid membrane as well as along the vallecular mucosa) and intraoperative assessment (neoplastic spread to the preepiglottic space identified on endoscopic biopsies also in one case). Sixteen of 16 cases were cor-

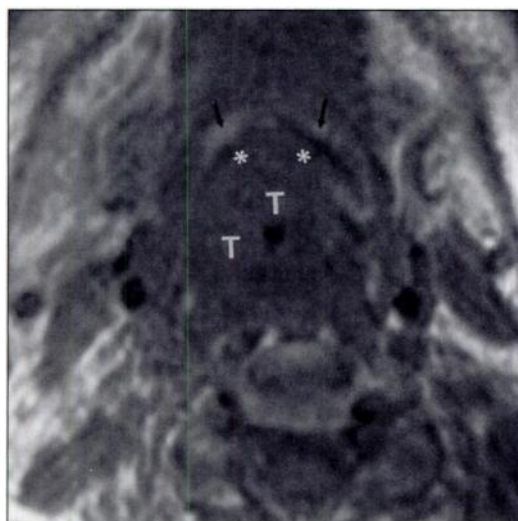


Fig. 2.—Neoplastic invasion of preepiglottic space in 70-year-old man with supraglottic (epiglottic) laryngeal squamous cell carcinoma. Axial T1-weighted MR image at level of hyoid bone (arrows) shows replacement of preepiglottic space fat by tumor (asterisks). Extensive neoplastic infiltration of preepiglottic space with extension into paraglottic fat was confirmed on pathologic examination of total laryngectomy specimen. T = primary tumor.

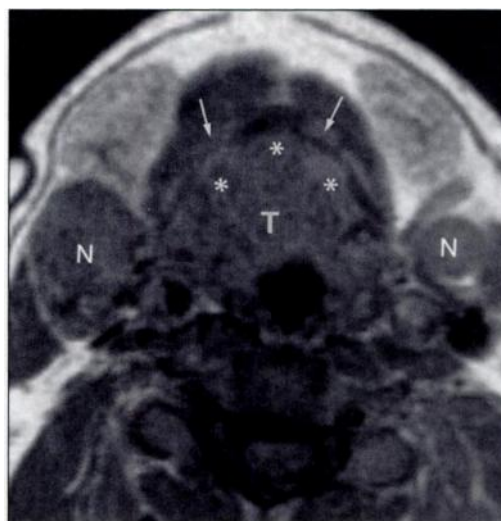


Fig. 3.—Neoplastic infiltration of preepiglottic space confirmed on pathologic examination in 62-year-old man with carcinoma of tongue base. Unenhanced axial T1-weighted MR image (TR/TE, 600/17; section thickness, 5 mm) shows extensive replacement of fat by soft tissue in preepiglottic space (asterisks). Note hyoid bone (arrows) and adenopathy (N). T = primary tumor.

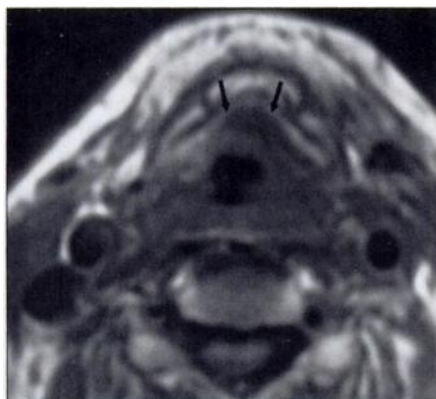


Fig. 4.—70-year-old woman with supraglottic laryngeal (epiglottic) carcinoma with subtle neoplastic spread into preepiglottic space interpreted on MR imaging and confirmed on pathologic examination after supraglottic laryngectomy. Axial unenhanced T1-weighted image (TR/TE, 600/17; section thickness, 5 mm) shows mild attenuation of fat in preepiglottic space seen as soft-tissue signal intensity (arrows).

rectly predicted to be positive by MR imaging, resulting in a sensitivity of 100% (Table 1).

Twenty-five patients had no invasion of the PEF (15 cases were confirmed by direct pathologic evaluation of the preepiglottic space of the laryngectomy specimens; in eight cases the absence of neoplastic infiltration of the preepiglottic space was determined by circumferential negative surgical margins of the local tumor resections at histologic evaluation). Two patients with T1 lesions were treated with only radiation and were deemed to have no invasion of the preepiglottic space on the basis of very small size of their tumors, normal MR examinations, and, importantly, no evidence of tumor recurrence for 2 years after treatment. Of these

TABLE 1 Radiologic-Pathologic Correlation in Examination of Patients for Neoplastic Invasion of Preepiglottic Space		
Finding	<i>n</i>	%
True-positive	16	
True-negative	21	
False-positive	4	
False-negative	0	
Sensitivity		100
Specificity		84
Positive predictive value		80
Negative predictive value		100
Accuracy		90

25 cases, 21 were correctly interpreted as negative on MR imaging; however, four of the 25 were incorrectly interpreted as positive. These findings resulted in an overall specificity of 84%. In two of four false-positive cases, effacement of the fat in the preepiglottic space by large, exophytic tumors with secondary edema in the fat was mistaken for invasion (Fig. 5). In a patient with a supraglottic laryngeal (aryepiglottic fold) carcinoma that had extended to the hypopharynx (piriform sinus), neoplastic spread into the paraglottic space was mistaken for PEF invasion (Fig. 6). In the fourth false-positive case, glandular tissue in the preepiglottic space may have been mistaken for abnormal soft tissue.

In patients treated with prior radiation therapy, MR imaging may be confusing in that radiation edema could be mistaken for tumor or the tumor could be obscured. Only four of the 41 patients in this study had radiation therapy for unrelated head and neck carcinomas (1 year or more before treatment of their new carcinomas). In three of these four patients, MR images were correctly interpreted as no PEF invasion, which was confirmed on pathologic examination of the supraglottic or total laryngectomy specimens; in the other patient, MR images were correctly interpreted as positive for PEF invasion, which was also confirmed on histologic evaluation of the laryngectomy specimen.

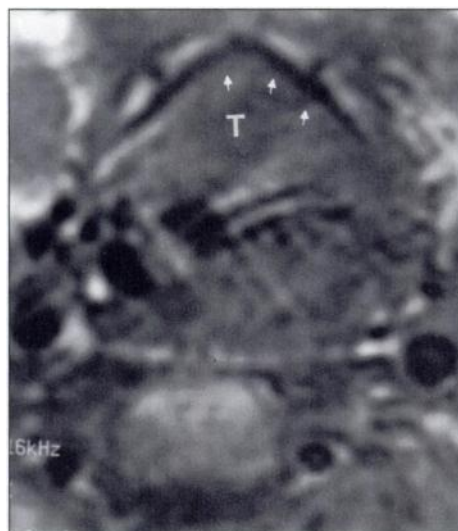
Given an interpretation of invasion of the PEF by assessment of MR images, the positive predictive value was 78% for PEF invasion on the basis of histologic evaluation of the surgical specimen and 80% when including those patients with positive findings for invasion on the basis of clinical assessment (palpation of the tumor externally along the neck due to gross extension through the thyrohyoid membrane). Given an interpretation of normal PEF on MR imaging (negative predictive value), 100% of patients did not have PEF invasion. The overall accuracy was 90% (Table 1).

Discussion

Management of carcinomas of the oropharynx, especially the tongue base, as well as the supraglottis and glottis is important because these structures play vital roles in swallowing and speech. The best chance for cure is aggressive treatment at initial presentation based on



A



B

Fig. 5.—48-year-old man with left oropharyngeal carcinoma (tonsil extending into tongue base). MR images were interpreted as positive for preepiglottic space invasion; however, pathologic examination after partial laryngectomy showed preepiglottic fat uninvolved by tumor, constituting false-positive MR examination. **A**, Sagittal T1-weighted image (TR/TE, 600/17; section thickness, 5 mm) shows mild attenuation and soft-tissue stranding of preepiglottic fat (arrows). Note exophytic tumor (m) and tumor extending from base of tongue (BOT). Epiglottis (E) is thickened; on pathologic examination, epiglottis was edematous but uninvolved with tumor. **B**, Axial T1-weighted image (600/17; section thickness, 5 mm) shows attenuation of preepiglottic fat (arrows) related to mass effect from large, exophytic tumor (T) that was basis for false-positive MR interpretation.

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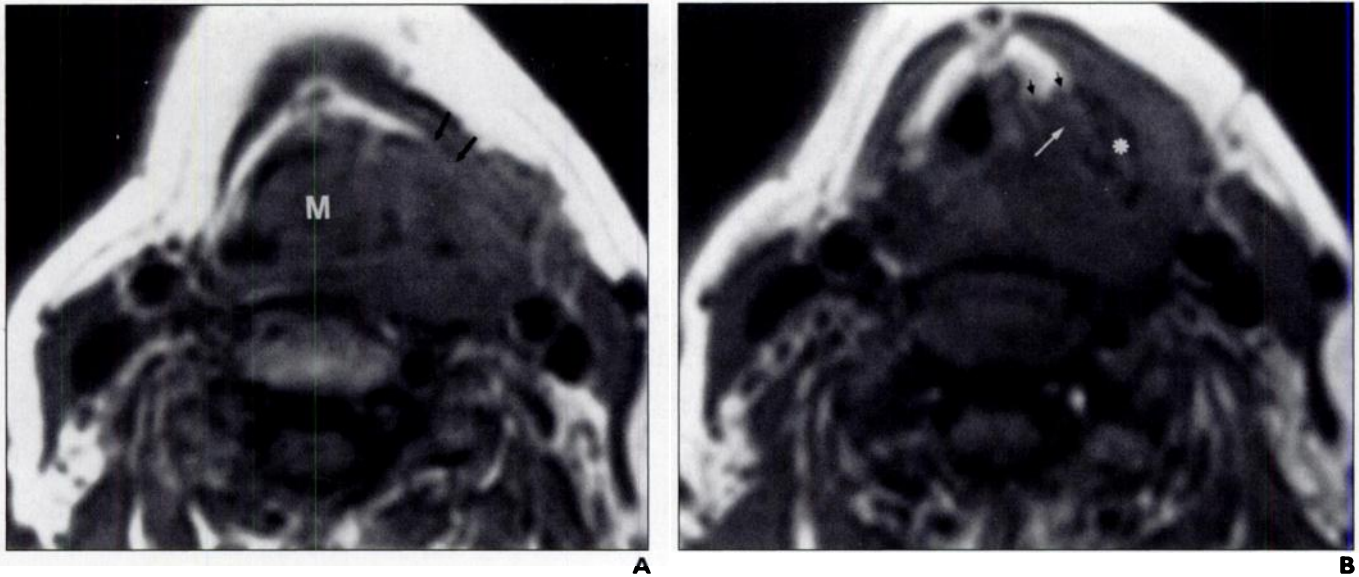


Fig. 6.—Unenhanced axial T1-weighted images (TR/TE, 600/17; section thickness, 5 mm) of supraglottic (aryepiglottic fold) carcinoma with extension to hypopharynx (piriform sinus) (T4 cancer) in 59-year-old woman.

A, Large exophytic tumor (M) fills laryngeal airway. Note soft-tissue replacement of fat on left (arrows).

B, MR image obtained more inferiorly than **A** shows tumor replacing fat (white arrow) incorrectly interpreted on MR image as preepiglottic space invasion. On pathologic examination of total laryngectomy specimen, this finding represented paraglottic space invasion. In retrospect, thin hypointense band (black arrows) probably represents thyroglottic ligament, a fibrous barrier demarcating preepiglottic and paraglottic spaces. Note neoplastic invasion of thyroid cartilage with replacement of marrow by soft tissue (asterisk).

accurate clinical staging. Each subsite of the pharynx and larynx is treated individually by the head and neck oncologic surgeon. The supraglottis includes the following subsites: the epiglottis, the aryepiglottic folds, the false vocal cords, and the top of the arytenoid cartilage. Staging of supraglottic carcinoma is based on subsite involvement, true vocal cord mobility, and cartilaginous or submucosal invasion. T1 and T2 lesions—involvement of one or more than one subsite, respectively—have normal vocal cord mobility and good cure rates by radiotherapy alone or combined therapy (local tumor resection and radiation) [4–6]. Stage T3 lesions, as classified by the American Joint Committee on Cancer staging [7], include those tumors confined to the larynx that have vocal cord fixation or preepiglottic space extension. Epiglottic carcinoma spreads to the preepiglottic space by direct anterior penetration through fenestrations in the epiglottis or by epiglottic cartilage destruction [8–10]. Treatment of T3 tumors usually necessitates supraglottic or total laryngectomy [11]. Tumors that are stage T4 include lesions with thyroid cartilage invasion or extralaryngeal spread [7].

The oropharynx is composed of the tongue base (posterior third of the tongue), the tonsils and tonsillar pillars, the inferior surface of the soft palate, the vallecula, and the posterior and

superior pharyngeal walls between the undersurface of the soft palate and the tip of the epiglottis. T1–T3 staging of oropharyngeal carcinomas is based on tumor size. Carcinomas, in particular those involving the tongue base, have an increased risk of preepiglottic space invasion. Although the hyoepiglottic ligament is a relatively resilient barrier to tumor extension, when tongue base cancers infiltrate the preepiglottic space, they do so directly through the hyoepiglottic ligament [12].

Imaging plays a critical role in the detection of lymphadenopathy, cartilage invasion, and tumor spread into the submucosal spaces of the neck [13–15]. Unless gross neoplastic infiltration of the PEF with extension through the thyrohyoid membrane occurs such that the tumor is palpable externally in the neck at this level, assessment for preepiglottic space invasion on physical and endoscopic examination is difficult [2].

The critical submucosal spaces that surround the larynx are the preepiglottic and the paraglottic spaces [16]. The preepiglottic space is bounded superiorly by the hyoepiglottic ligament, inferiorly by the conus elasticus, posteriorly by the epiglottis and quadrangular membrane, and anteriorly by the thyroid cartilage and the thyrohyoid membrane [16–18]. The preepiglottic space is triangular in configuration and its contents include predominantly

adipose tissue as well as collagen fibers and fibrous tissue [16] (Fig. 1). Although the preepiglottic space does not contain lymph nodes, rich lymphatics abound, crossing the space [1, 6, 19]. In addition, lymphatic communications can sometimes be found extending from the preepiglottic space to the paraglottic space [19].

The upper portion of the paraglottic space is located anterior to the piriform sinus and is medial to the thyroid lamina throughout its cranio-caudad extent [16]. The paraglottic space is triangular and contains fat and small intrinsic laryngeal muscles. Ligaments are important barriers to the extension of laryngeal carcinoma [20]. Posteriorly and inferiorly, the preepiglottic and paraglottic spaces are distinct anatomically on pathologic dissection, separated by a thin membrane composed of fibrous connective tissue that has been referred to as the thyroglottic ligament (Fig. 6).

When the deep paralaryngeal spaces are uninvolved by tumor (and no interarytenoid or bilateral true vocal cord disease occurs), local resection or radiation therapy is possible, allowing preservation of swallowing and speech [4–6, 21, 22]. When neoplastic infiltration of the preepiglottic space by oropharyngeal (especially tongue base) and supraglottic laryngeal carcinomas occurs, management involves a more extensive supraglottic laryngectomy and sometimes total laryngectomy [1, 12, 22–25].

In a supraglottic laryngectomy, the upper half of the thyroid cartilage, the epiglottis, the aryepiglottic folds, the false vocal cords, and the PEF are completely resected. In addition, because the preepiglottic space contains a rich lymphatic system [1, 16], neoplastic invasion of the space is associated with increased lymphatic metastases [3]. Hence, accurate radiologic detection of spread to the preepiglottic space will identify patients at highest risk for cervical lymph node metastases [3]. These patients may benefit from bilateral cervical lymphadenectomies at the time of supraglottic laryngectomy. Finally, when a supraglottic carcinoma extends across the thyroglottic ligament into the paraglottic space, potential exists for direct extension to the glottic level, which may necessitate partial or total laryngectomy rather than a supraglottic laryngectomy. In a supracricoid laryngectomy with cricohyoidopexy, in addition to resection of structures normally taken in a supraglottic laryngectomy, the entire thyroid cartilage as well as the glottis and the bilateral paraglottic spaces are resected [26, 27]. Supraglottic and total laryngectomies raise quality of life issues with respect to the patient's ability to swallow or communicate, not to mention the prognostic implications of extralaryngeal spread. When supraglottic laryngectomy is combined with base of tongue resections, the ability to speak, swallow, and breathe without a tracheostomy comes into question.

Pathologic evaluation of surgical specimens has shown a high incidence of preepiglottic space invasion (T3) in patients with supraglottic carcinomas clinically staged as T1 or T2 [3, 8]. Preepiglottic invasion is more common with supraglottic carcinomas occurring below the level of the hyoid bone [24, 28] than for those suprahoid in location (15% and 6%, respectively) [24].

CT and sonography have met with limited success in evaluating for submucosal spread [2, 14, 29–32]. The few investigations that have evaluated for the presence of neoplastic invasion of the deep paralaryngeal spaces with sonography are limited by small sample sizes and little pathologic correlation [2, 33]. Love-day et al. [2] described detection of clinically unsuspected spread into the preepiglottic space in four of 14 patients with advanced tumors by sonography; however, only one case was pathologically proven. Furthermore, the authors did not address the issue of potential false-negative examinations. A technical drawback to sonography of the larynx is that sonographic examination is frequently impeded because the larynx is an air-containing struc-

ture that is housed in a calcified cartilaginous framework. Both air and calcium prevent through-transmission of the sound beam and, hence, prevent adequate visualization of the larynx and the surrounding submucosal spaces. Similarly, although some investigators have suggested that CT is accurate in detecting neoplastic invasion of the preepiglottic space, the sample sizes in many studies were small and direct radiologic-pathologic correlation was poor [13, 15, 29]. Equally important, much of the published work evaluated tumors that were already stage T3 or T4 at initial clinical assessment (before imaging) [13, 15, 30, 34]. In these advanced tumors, detection of preepiglottic spread radiologically would have less impact on management.

Cusumano et al. [30] evaluated nine patients with T3 epiglottic carcinomas. The CT interpretation correlated with the histopathology in nine (75%) of 12 cases. Two false-negative cases were found in which microinvasion of tumor in the preepiglottic space was determined on pathologic evaluation, and one false-positive study was found in which inflammation in the PEF was mistaken for neoplastic disease. Other investigators have reported a high rate of false-positive CT interpretations (five [23%] of 22 cases) for preepiglottic spread, which, at pathologic evaluation, was believed to be attributed to glandular tissue and small ligaments [15]. Zeitels et al. [8] studied 22 supraglottic tumors staged clinically as T1 or T2 and found preepiglottic spread in one third of cases at pathologic evaluation that was not detected on CT (false-negatives). In a different study, Zeitels and Vaughn [3] also found that in 36 epiglottectomy specimens for epiglottic cancer clinically staged as T1 or T2 tumors, 24 cases (67%) had preepiglottic spread. In the series of Zeitels and Vaughn, 50% of patients with preepiglottic spread had lymph node metastases detected by neck dissection or by development of cervical nodal disease in the follow-up period compared with 22% without preepiglottic spread.

Little data are available on the accuracy of MR imaging in evaluating preepiglottic space involvement by carcinomas, and the few studies published are on low-field-strength (0.5-T) systems or include small numbers of patients [34, 35]. The ability of MR imaging to accurately show PEF invasion would provide accurate preoperative staging, resulting in more definitive and cost-effective patient management. In the absence of imaging studies, assessment of preepiglottic space invasion preoperatively is difficult, and determination

of neoplastic spread can be made only with large tumors that have such extensive PEF invasion that they are palpable either at the level of the vallecular mucosa or externally at the thyrohyoid membrane. In addition, a deeply invasive ulcer at the level of the vallecular mucosa on the lingual surface of the epiglottis is suggestive of early preepiglottic space invasion. Because of the superior soft-tissue resolution of high-field-strength (1.5-T) MR imaging as well as its multiplanar capabilities compared with other available imaging techniques, MR imaging seems to lend itself nicely to evaluation for neoplastic spread into the deep submucosal spaces.

In this study MR imaging accurately predicted tumor extension into the preepiglottic space and showed that, of 16 patients with proven PEF neoplastic invasion, all invasions were correctly predicted (sensitivity, 100%) (Figs. 2–4). In 25 patients without PEF infiltration, negative findings were correctly predicted on MR images in 21 patients (specificity, 84%). Positive findings for PEF invasion were incorrectly predicted in four patients. Causes of false-positive interpretations included effacement of the PEF by large tumors, which was mistaken for invasion (Fig. 5), and paraglottic space invasion, which was mistaken for preepiglottic spread (Fig. 6).

This study needs to be followed by one that has a large sample size. Importantly, future studies need to determine how often the MR detection of preepiglottic space invasion would upstage tumors clinically staged as T1 or T2 to T3 lesions—possibly necessitating a change in management (supraglottic or total laryngectomy as opposed to more conservative therapy). In this preliminary work, we were unable to determine this frequency because of the retrospective nature of the study and because the staging of patients in their medical records reflected both clinical and radiologic findings. Another limitation of this investigation was the potential for missing microinvasion of the preepiglottic space (false-negative MR interpretations). Fifteen of the 25 cases interpreted as negative were confirmed at supraglottic or total laryngectomy. In the other 10 patients, microinvasion could possibly have been missed on MR imaging; however, in patients with epiglottic carcinoma treated with epiglottectomy or radiation therapy, no endoscopic evidence of preepiglottic spread (the lingual surface of the cartilage was intact) was found, and operative specimens showed the margins to be free of tumor ($n = 4$). Similarly, in the patients with oropharyngeal carcinomas

treated with local resection and radiation therapy, the margins of the resected specimens were free of tumor ($n = 4$). To our knowledge, no studies have clearly shown at this time that microinvasion of the preepiglottic space is a contraindication to composite resection or radiation therapy. In the 10 patients in this study with MR images interpreted as normal PEF findings who were treated conservatively, all are alive at 1–2 years after treatment. One patient had a local recurrence, and one patient developed cervical lymph node metastases.

In conclusion, MR imaging is a highly reliable and sensitive technique for identifying neoplastic infiltration of the preepiglottic space that frequently cannot otherwise be assessed clinically or endoscopically. The reviewers believed that unenhanced sagittal and axial T1-weighted images were particularly useful because fat-saturation artifacts may degrade T2-weighted and contrast-enhanced images. Identification of PEF invasion often requires a change in surgical therapy in that a supraglottic or total laryngectomy as opposed to a local composite resection may be necessary. Pitfalls that may result in false-positive interpretations include large tumors that may efface but not infiltrate the PEF, benign edematous changes in the PEF, and lymphatic or glandular tissue along the base of the epiglottis that may be mistaken for neoplastic infiltration.

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