2
Head and Neck

Standard Imaging Methods for Head and Neck

Introduction

Unless otherwise indicated, the following applies both to CT and MRI of the head and neck.

① The standard CT slice thickness is ≤ 3 mm regardless of the conditions.

② Reconstructed CT images are generated for the transverse plane with soft tissue and bone conditions and for the coronal and/or sagittal plane as needed.

③ For contrast-enhanced CT, either 100 mL or twice the patient's weight in mL of a nonionic contrast agent at a concentration of 240 to 300 mgI/mL is intravenously injected at a rate of 2 to 3 mL/second, and imaging is performed 50 to 70 seconds later. For CTA, a high-concentration contrast medium is used.

④ MRI slice thickness is 3 mm, and the slice gap is 1 mm. Although an FOV of 160 to 180 mm is the standard for local evaluation, decreases in the SNR should be taken into account, and the optimal imaging conditions for each system used.

⑤ With contrast-enhanced MRI, a gadolinium contrast medium is administered intravenously at a dose equal to the patient's weight (kg) multiplied by 0.1 mmol/kg, and imaging is performed.

⑥ MRI is generally more suitable for the local evaluation of head and neck cancer. However, contrast-enhanced CT is suitable for the hypopharynx and larynx.

⑦ Fat-suppressed contrast-enhanced 3D T1-weighted imaging [CUBE (GE), SPACE (Siemens), VISTA (Philips), MPV (Canon Medical Systems), iso FSE (Hitachi)] is used for purposes such as evaluating the detailed lesion distribution and diagnosing perineural spread, and reconstruction allows observations in any arbitrary plane. Although not indicated in the examples of protocols, it can be considered as needed.

⑧ There are a variety of imaging methods for fat suppression, with differences in the suppressive effect depending on the system and imaging method used. It is important to use them as needed based on the advantages and shortcomings of each.

Orbit and optic nerve

1. Overview

CT is suitable for screening for conditions such as proptosis, oculomotor dysfunction, double vision, visual impairment, trauma, foreign bodies, inflammation, and tumors. MRI is sensitive for purposes such as detecting small lesions, hemorrhage, and melanin pigment associated with malignant melanoma of the eyeball. Tumors and inflammation of the optic nerve or orbit are good indications for contrast-enhanced MRI. When optic nerve and intracranial lesions are suspected based on the presence of a condition such as neuromyelitis optica, MRI is also very useful because it can evaluate these lesions in a single examination

(Fig. 1). Screening for intraorbital foreign bodies is first performed by CT, and evaluation by MRI is useful if the presence of metal is ruled out by CT.[1, 2)]

2. Detailed discussion

① CT (Table 1)

(1) Non-contrast CT is standard, but contrast-enhanced imaging is performed if inflammation or a tumor is present. Non-contrast CT is also useful for pathological changes associated with calcification, such as venous malformation and retinoblastoma.

(2) The imaging range should sufficiently include the orbit.

(3) Thin slices approximately 1-mm thick can be tried for observation of foreign bodies or orbital fractures.

② MRI (Table 2)

(1) Using a head coil, imaging is performed over a range that includes the orbit and cavernous sinus.

(2) Caution is required regarding eye-movement artifacts; imaging is performed with the patient at rest with eyes closed.

(3) Contrast-enhanced imaging is performed for tumors and inflammation. If contrast-enhanced imaging cannot be performed, fat-suppressed T2-weighted, STIR, or diffusion-weighted imaging may be informative.

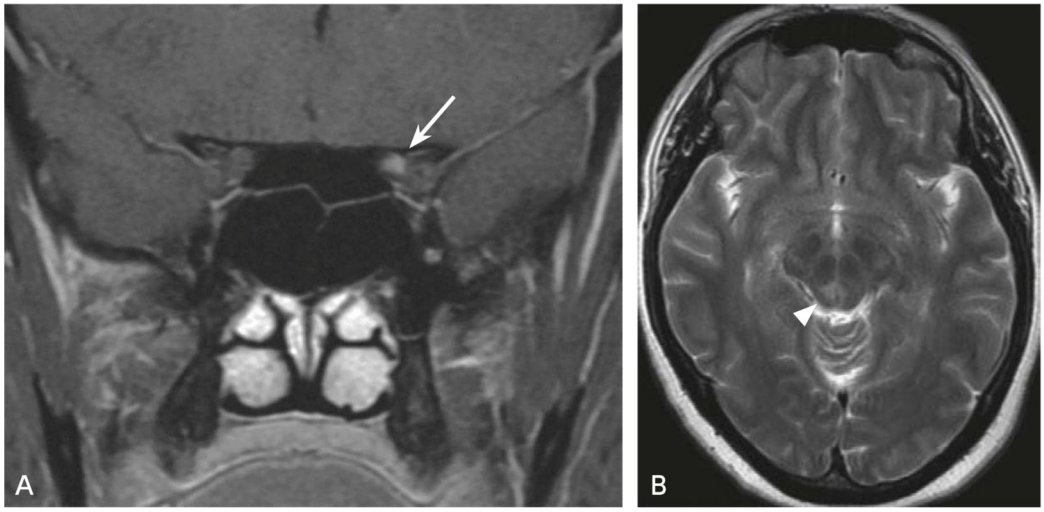

Figure 1. Neuromyelitis optica

A: Orbital MRI, fat-suppressed, contrast-enhanced T1-weighted coronal image; B: Head MRI performed at the same time, T2-weighted transverse image

Contrast enhancement of the left optical nerve is seen in A (→). An area of faint hyperintensity is seen in the periphery of the cerebral aqueduct (▷), consistent with neuromyelitis optica.

Table 1. Examples of protocols for the orbit: 64-row MDCT system

Imaging Range	Reconstruction Function	Scan Slice Thickness	Reconstruction Slice Thickness	Reconstruction Slice Interval	FOV	WW/WL	Image Processing
From the superior margin of the dentition to 1 cm cranial to the supraorbital margin	For soft tissue	≤ 0.625 mm	≤ 2 mm	Same as at left	160 mm	350/30	Coronal plane Sagittal plane added as appropriate
Same as above	For bone	≤ 0.625 mm	≤ 2 mm	Same as at left	160 mm	4,000/500	Coronal plane Sagittal plane added as appropriate

Note 1: The imaging dose is selected by taking into account radiation exposure of the lens, and selective dose-reduction mechanisms are aggressively used.
Note 2: If the patient has no teeth, imaging is performed 1 cm caudal to the inferior margin of the hard palate in reference to the lateral view of the image used to determine location.

Table 2. Examples of orbit sequences: 3T MRI system, head coil

Imaging Method	Sequence	TR/TE	Slice Thickness	Other
① T2-weighted/transverse	FSE	4,000/85 ms	3 mm	The entire brain is imaged if a demyelinating disease such as NMO* is suspected.
② Fat-suppressed T2-weighted/coronal	FSE	4,000/85 ms	3 mm	Changed to coronal STIR if fat suppression is poor due to the effect of a metal object, etc.
③ T1 weighted/transverse	SE	400/10 ms	3 mm	
④ Fat-suppressed T1-weighted/coronal	FSE	479/12.3 ms	3 mm	
⑤ Diffusion-weighted	EPI	6,500/55.3 ms	3 mm	The entire brain is imaged and an ADC map generated if a demyelinating disease such as NMO* is suspected.
⑥ Fat-suppressed, contrast-enhanced T1-weighted/transverse	FSE	479/12.3 ms	3 mm	
⑦ Fat-suppressed, contrast-enhanced T1-weighted/coronal	FSE	479/12.3 ms	3 mm	Changed to DIXON contrast-enhanced T1-weighted coronal if fat suppression is poor due to effect of a metal object, etc.

Note 1: Imaging performed at rest with eyes closed
*NMO: neuromyelitis optica

(4) Attention should be paid to decreases in the SNR if artifacts caused by an item such as a dental prosthetic are prominent with fat-suppressed T2-weighted imaging, and STIR imaging is used instead.
(5) Note that makeup occasionally results in artifacts and hinders diagnostic imaging.
(6) Diffusion-weighted imaging may be useful in diagnosing conditions such as malignant lymphoma, orbital cellulitis, IgG4-related disease, retinoblastoma, optic neuritis, lacrimal gland tumors, and epidermoid cysts.[3)]

Nasal cavity and paranasal sinuses

1. Overview

The nasal cavity and paranasal sinuses are a complex mix of pneumatic space, bone, and soft tissue, which show good tissue contrast on CT. CT provides higher spatial resolution than MRI and is also excellent for visualizing small soft tissue lesions in pneumatic space and minor bone erosion. In chronic sinusitis, CT is good for showing items such as the affected area, normal variants of the nasal cavity and paranasal sinuses, as well as sinusitis complications, and therefore plays an important role in determining a procedure for endoscopic sinus surgery (ESS). In conditions such as eosinophilic sinusitis and allergic fungal rhinosinusitis, allergic mucin in affected sinuses shows high attenuation on CT. Changes such as polyps, cysts, mucosal thickening, and tumors show similar soft tissue attenuation on CT. MRI is useful for differentiating between these soft-tissue lesions and changes such as granulomatous lesions and mycotic infections, and tumors of the nasal cavity and paranasal sinuses are particularly good indications for MRI (Fig. 2). Contrast-enhanced MRI shows tumor and inflammation localization and intracranial extension well. CT is the first choice imaging modality for bone fractures, including those of the nasal cavity and paranasal sinuses.[4-6)]

2. Detailed discussion

① CT (Table 3)

(1) A plain examination is used for screening. Contrast-enhanced imaging is performed for tumors.

(2) The imaging range sufficiently includes the nasal cavity and paranasal sinuses.

(3) Observation in the coronal and transverse planes is standard.

(4) The addition of sagittal plane images is useful for observations such as those of the drainage route and normal variants of the paranasal sinuses and the course of the anterior and posterior ethmoidal arteries.

(5) In the nasal cavity and paranasal sinuses, bone and pneumatic space adjoin in a complex fashion, making them susceptible to artifacts caused by partial volume effects. Consequently, a slice thickness of ≤ 2 mm is used.

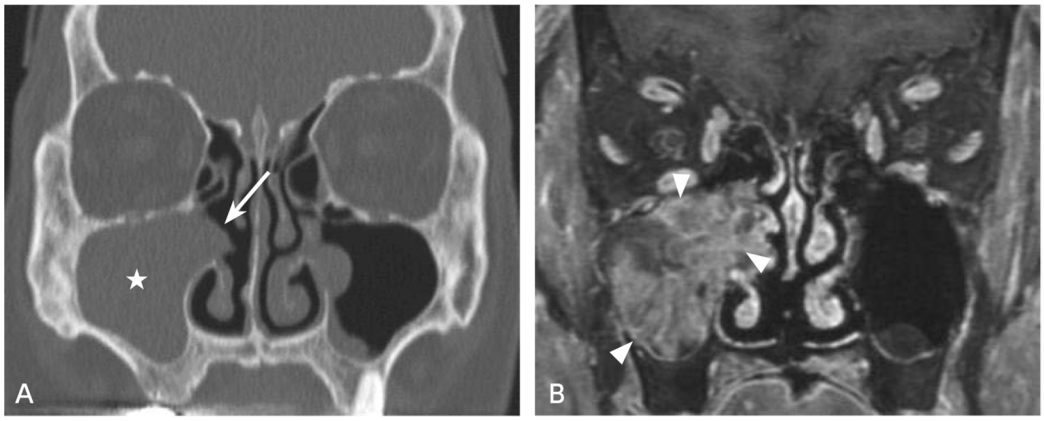

Figure 2. Inverted papilloma

A: Non-contrast CT, bone algorithm, coronal image; B: MRI, fat-suppressed, contrast-enhanced, T1-weighted coronal image
In A, soft tissue attenuation is seen in the right maxillary antrum (☆), and the maxillary infundibulum is widened (→). In B, convoluted solid masses are seen in the area from the right maxillary antrum to the middle meatus (▷), which is typical for inverted papilloma.

Table 3. Examples of protocols for the nasal cavity and paranasal sinuses: 64-row MDCT system

Imaging Range	Reconstruction Function	Scan Slice Thickness	Reconstruction Slice Thickness	Reconstruction Slice Interval	FOV	WW/WL	Image Processing
From the inferior margin of the dentition to 1 cm cranial to the superior margin of the frontal sinus	For soft tissue	≤ 0.625 mm	≤ 2 mm	Same as at left	160 mm	350/30	Coronal plane Sagittal plane added as appropriate
Same as above	For bone	≤ 0.625 mm	≤ 2 mm	Same as at left	160 mm	4,000/500	Coronal plane Sagittal plane added as appropriate

Note 1: The imaging dose is selected by taking into account radiation exposure of the lens, and selective dose-reduction mechanisms are aggressively used.
Note 2: If the patient has no teeth, imaging is performed 1 cm caudal to the inferior margin of the hard palate in reference to the lateral view of the image used to determine location.

Table 4. Examples of sequences for the nasal cavity and paranasal sinuses: 3T MRI system, head and neck coil

Imaging Method	Sequence	TR/TE	Slice Thickness	Other
① T2-weighted/transverse	FSE	4,000/85 ms	3 mm	
② T1-weighted/transverse	SE	480/10 ms	3 mm	
③ Fat-suppressed, T2-weighted/coronal	FSE	4,000/85 ms	3 mm	
④T1-weighted/coronal	SE	480/10 ms	3 mm	
⑤ Diffusion-weighted	EPI	6,000/55.3 ms	3 mm	STIR, ADC mapping
⑥ Contrast-enhanced, T1-weighted/transverse	SE	480/10 ms	3 mm	
⑦ Fat-suppressed, contrast-enhanced, T1-weighted/coronal	FSE	667/7.8 ms	3 mm	

Note: STIR is used as the method of fat suppression in diffusion-weighted imaging in view of the poor fat suppression that results from magnetic field non-uniformity.

② MRI (Table 4)

(1) A head and neck coil is used for imaging, and the imaging range includes the nasal cavity and paranasal sinuses sufficiently.

(2) Areas near pneumatic spaces are prone to susceptibility artifacts. Particular attention should be paid to decreased image quality with fat suppression.

(3) Contrast-enhanced imaging is performed for tumors and inflammation.

(4) Attention should be paid to decreases in the SNR if artifacts caused by an item such as a dental prosthetic are prominent with fat-suppressed T2-weighted imaging, and STIR imaging is used instead.

(5) Diffusion-weighted imaging is useful for purposes such as determining whether a sinonasal tumor is benign or malignant and qualitatively diagnosing conditions such as malignant lymphoma. Because of the large amount of airspace, however, diffusion-weighted imaging is prone to susceptibility artifacts, which often makes the evaluation of small lesions particularly difficult.

Oral cavity

1. Overview

In this region, oral cavity cancer, typified by tongue cancer, abscesses, and inflammatory diseases such as osteomyelitis are important. CT is useful for evaluating aspects such as tumor extension, bone invasion, and lymph node metastasis in oral cavity cancer. However, metal artifacts caused by dental treatment often interfere with diagnosis. Gold is the metal most commonly used in dental care in Japan, and there are far fewer metal artifacts with MRI than with CT.[7] Contrast-enhanced MRI shows the tumor extension of oral cavity cancer well and is the first-choice imaging modality (Fig. 3). Contrast-enhanced CT is used for evaluation if MRI is contraindicated. Diagnostic imaging of inflammatory disease of the oral cavity region is a good indication for contrast-enhanced CT.[8, 9] ^{18}F-FDG PET sensitively detects oral cavity cancer and metastatic lymph nodes and is also useful for screening for distant metastasis. PET should be used if postoperative recurrence or metastasis is suspected, but no lesions are clearly seen on CT or MRI. With regard to its indications, however, careful judgement based on CT and MRI findings is required.[10-12]

2. Detailed discussion

① Standard CT imaging method when inflammation is suspected

(1) Contrast-enhanced CT is performed.

(2) Abscesses may broadly progress vertically. Imaging is performed from the skull base to the superior mediastinum. If an abscess is present, additional imaging of the chest is performed.

(3) Bone algorithm is always added for dental caries and osteomyelitis.

② Standard imaging methods when a tumor is suspected

(1) CT

(A) CT is suitable for evaluating tumor extension, maxillary invasion, and cervical lymph node metastasis in oral cavity cancer.

(B) Contrast-enhanced CT is performed.

(2) MRI (Table 5)

(A) MRI shows the relationship between tumors and the deep lingual muscles well and thus contributes to accurate T-staging.

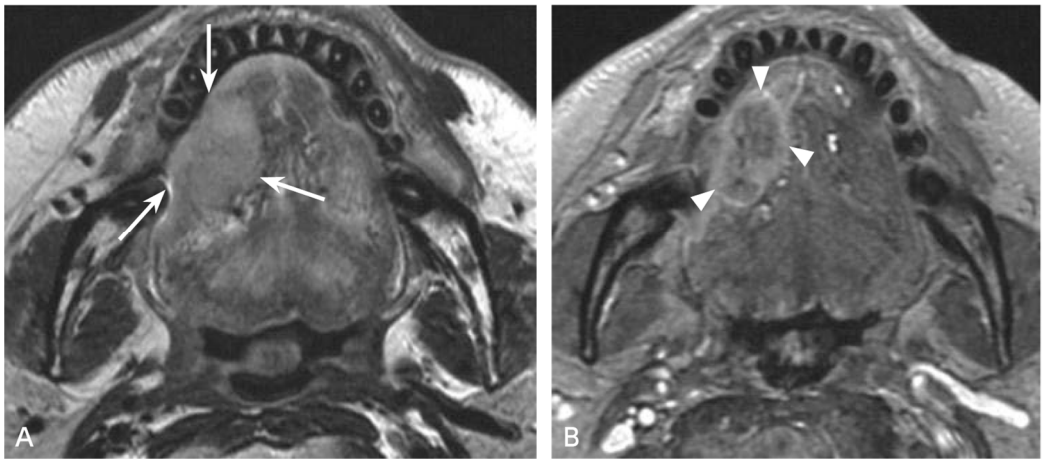

Figure 3. Tongue cancer

A: MRI, T2-weighted image; B: MRI, fat-suppressed, contrast-enhanced, T1-weighted image
In A, a mass with an irregular border that is nearly isointense with muscle is seen on the right margin of the tongue (→). In B, strong contrast enhancement is seen at the margin of the mass (▷).

Table 5. Examples of sequences for the oral cavity: 3T MRI system, head and neck coil

Imaging Method	Sequence	TR/TE	Slice Thickness	Other
① T2-weighted/transverse	FSE	4,000/85 ms	3 mm	
② T1-weighted/transverse	SE	480/10 ms	3 mm	
③ T2-weighted/coronal	FSE	4,000/85 ms	3 mm	
④T1-weighted/coronal	SE	480/10 ms	3 mm	
⑤ Diffusion-weighted	EPI	6,000/55.3 ms	3 mm	STIR, ADC mapping
⑥ Contrast-enhanced, T1-weighted/transverse	SE	480/10 ms	3 mm	
⑦ Fat-suppressed, contrast-enhanced, T1-weighted/transverse or coronal	FSE	667/7.8 ms	3 mm	

Note 1: The examinee is asked to take small breaths, minimize tongue movement, and appropriately refrain from swallowing.
Note 2: STIR is used as the method of fat suppression in diffusion-weighted imaging in view of the poor fat suppression that results from magnetic field non-uniformity.

(B) Imaging is performed using a head and neck coil, and the imaging range includes the area from the soft palate to the floor of the mouth sufficiently.

(C) Tongue movement and swallowing during imaging result in image quality deterioration. The patient is asked to minimize these movements.

Temporal bone

1. Overview

CT is often performed for conditions such as conductive hearing loss, chronic otitis media, mastoiditis, cholesteatoma, congenital hearing disorder, and facial paralysis and middle ear disorder/inner ear disorder

resulting from bone fracture. CT is good for showing the bone structure of the temporal bone and bone changes resulting from lesions (Fig. 4A).[13] MRI is performed after CT for detailed examination. It enables the characterization of soft tissue lesions and the observation of structures such as the facial and auditory nerves.

2. Detailed discussion

① CT (Table 6)

(1) Non-contrast CT can be considered standard. Contrast-enhanced imaging is performed for tumors.

(2) Tomograms with a thickness of ≤ 1 mm are generated using bone algorithm.

(3) The plane parallel to the hard palate is considered the transverse plane, and images in this plane are displayed together with coronal plane images, which are acquired in the plane perpendicular to the transverse plane.

② MRI (Table 7)

(1) T1- and T2-weighted transverse images are acquired. Contrast-enhanced imaging is also necessary for tumors.

(2) A slice thickness of 2 mm is ideal. However, care is needed because a decreased SNR interferes with diagnosis. The imaging conditions are therefore optimized for the system used.

(3) SSFP (e.g., FIEST-C, CISS, balanced FFE) enables the inner ear to be observed at high spatial resolution.

(4) Diffusion-weighted imaging with reduced susceptibility artifacts is useful for diagnosing cholesteatoma (Fig. 4B).

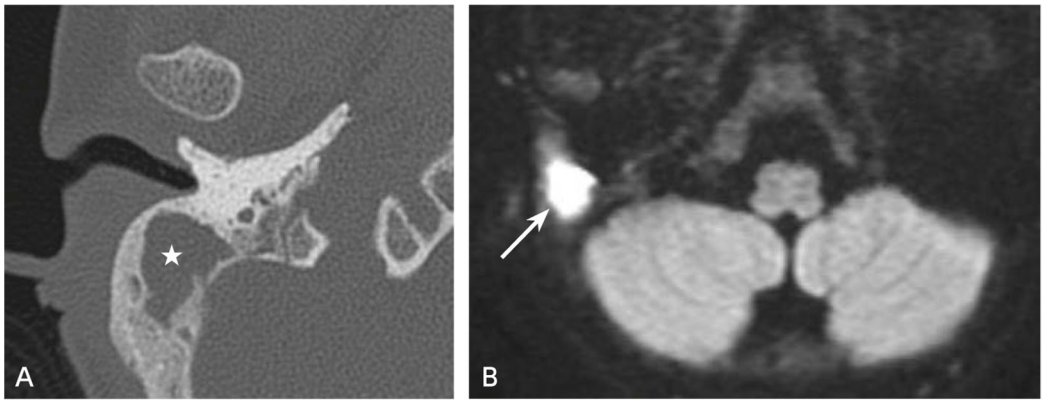

Figure 4. Right cholesteatoma

A: Non-contrast CT, bone algorithm; B: MRI, diffusion-weighted image

In A, no bony partition of the right mastoid air cells is seen, the soft tissue density is full, and there is associated bone erosion at the margin (☆). In B, the lesion shows distinct hyperintensity, consistent with cholesteatoma.

Table 6. Example protocol for the temporal bone: 64-row MDCT system

Imaging Range	Reconstruction Function	Scan Slice Thickness	Reconstruction Slice Thickness	Reconstruction Slice Interval	FOV	WW/WL	Image Processing
From the inferior margin of the mastoid air cells to 1 cm cranial to the petrous apex	For bone	≤ 0.625 mm	≤ 1 mm	Same as at left	≤ 100 mm	4,000/500	Coronal plane, sagittal plane added as appropriate Reconstruction enlarged separately for left and right Soft tissue algorithm added as appropriate

Note: An imaging plane that excludes the lens from the imaging range is selected.

Table 7. Examples of temporal bone sequences: 3T MRI system, head coil

Imaging Method	Sequence	TR/TE	Slice Thickness	Other
① T2-weighted/transverse	FSE	4,000/85 ms	2 to 3 mm	
② T1-weighted/transverse	SE	480/10 ms	2 to 3 mm	
③ T2-/T1-weighted/transverse	Balanced SSFP*	4.6/2.2 ms	1 mm	MPR generated 3D T2-weighted transverse imaging also feasible
④ Diffusion-weighted	EPI**	6,000/55.3 ms	3 mm	STIR, ADC mapping
⑤ Contrast-enhanced, T1-weighted/transverse	SE	480/10 ms	3 mm	Coronal plane added as appropriate
⑥ Contrast-enhanced, T1-weighted/transverse	3D FSPGR***	8.3/3.3 ms	1 mm	

Note: STIR is used as the method of fat suppression in diffusion-weighted imaging in view of the poor fat suppression that results from magnetic field non-uniformity.

*FIESTA-C/FIESTA (GE), CISS/True FISP (Siemens), Balanced FFE (Philips), True SSFP (Canon Medical Systems), balanced SARGE (Hitachi)

**EPI diffusion-weighted imaging is prone to susceptibility artifacts, particularly in areas of the temporal bone where air is prevalent. Consequently, if imaging can be performed, non-EPI diffusion-weighted imaging is preferable.

***FSPGR: fast spoiled gradient echo

Salivary glands

1. Overview

If salivary calculus is suspected clinically, this is a good indication for CT. MRI is more sensitive than CT for salivary gland inflammation. In salivary gland tumors, MRI is also superior to CT both for identifying the presence of lesions and diagnosing them qualitatively. Contrast-enhanced MRI with concomitant fat suppression is particularly useful for evaluating perineural spread. The change in contrast enhancement over time with dynamic contrast-enhanced MRI of parotid tumors and diffusion-weighted imaging with the measurement of ADC values can aid in differentiating benign from malignant parotid masses, particularly pleomorphic adenomas.[14, 15])

2. Detailed discussion

① CT

(1) Salivary calculus itself can be diagnosed with non-contrast CT. If contrast-enhanced CT is performed for a purpose such as evaluating associated sialadenitis, nearly all salivary calculi can be detected with the bone algorithm of contrast-enhanced CT.[16] To reduce radiation exposure, care should therefore be exercised in deciding whether to perform non-contrast CT (before contrast-enhanced imaging).

(2) Salivary calculus in the salivary duct may not be observable due to artifacts caused by dental prosthetics. The addition of plain radiography is useful.

② MRI (Table 8)

(1) A head and neck coil is used for imaging.

(2) Contrast-enhanced imaging is performed for tumors and inflammation.

(3) Fat-suppressed T2-weighted and STIR imaging may also be instructive for diagnosis.

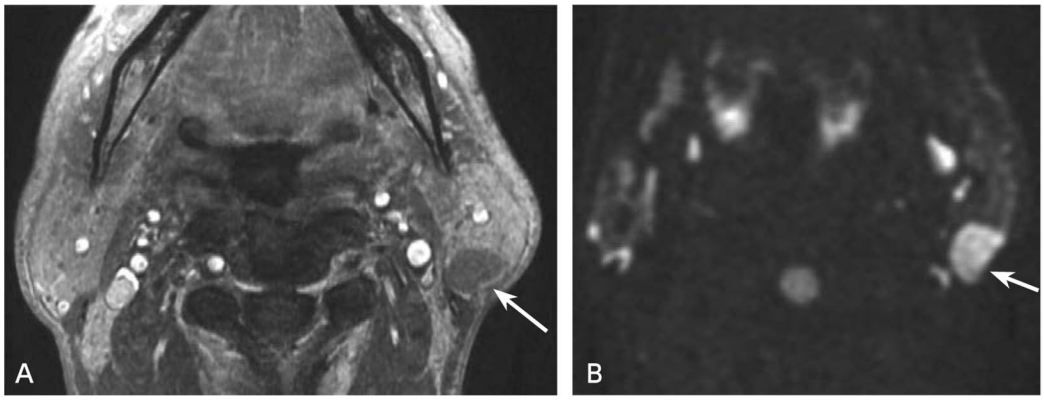

Figure 5. Warthin's tumor of the left parotid gland

A: MRI, fat-suppressed, contrast-enhanced, T1-weighted image; B: MRI, diffusion-weighted image
In A, a mass with distinct borders and uniform characteristics is seen in the lower dorsal region of the left parotid gland (→). In B, the mass shows hyperintensity (→). The ADC value is 0.80×10^{-3} mm^2/s. Although the findings are suggestive of a Warthin's tumor, caution is required in differentiating it from malignancy.

Table 8. Examples of sequences for the salivary gland: 3T MRI system, head and neck coil

Imaging Method	Sequence	TR/TE	Slice Thickness	Other
① T2-weighted/transverse	FSE	4,000/85 ms	3 mm	
② T1-weighted/transverse	SE	480/10 ms	3 mm	
③ STIR/coronal	STIR	8,800/60 ms	3 mm	
④ Fat-suppressed T1-weighted/coronal*	FSE	667/7.8 ms	3 mm	Imaging performed over a range that includes the cavernous sinus/the course of V3**
⑤ Diffusion-weighted	EPI	6,000/55.3 ms	3 mm	STIR, ADC mapping
⑥ Contrast-enhanced, T1-weighted/transverse (multiphase imaging)	3D FSPGR	5.6/2.7 ms	3 mm	Imaging at pre-injection and 30, 60, 90, 120, and 180 seconds after injection
⑦ Contrast-enhanced T1-weighted/transverse	SE	480/10 ms	3 mm	Coronal plane added as appropriate
⑧ Fat-suppressed, contrast-enhanced T1-weighted/coronal*	FSE	667/7.8 ms	3 mm	Imaging performed over a range that includes the cavernous sinus/the course of V3**

Note 1: The examinee is asked to take small breaths, minimize tongue movement, and appropriately refrain from swallowing.
Note: STIR is used as the method of fat suppression in diffusion-weighted imaging in view of the poor fat suppression that results from magnetic field non-uniformity.
*CHESS recommended
**V3: 3rd branch of the trigeminal nerve

(4) Diffusion-weighted imaging may be useful for determining whether a salivary gland tumor is benign or malignant and for diagnosing it qualitatively. However, because the ADC values of Warthin's tumors, which are benign, are low, overlap is seen between the ADC values of benign and malignant tumors (Fig. 5).

Upper and middle pharynx

1. Overview

Inflammatory disease of the upper and middle pharynx is a good indication for contrast-enhanced CT. MRI is the first choice of imaging examinations for nasopharyngeal tumors. It is useful for differentiating from malignant lymphoma and adenoid hypertrophy, and it allows the extent of tumor extension to be determined in detail. CT sensitively detects subtle changes in the cortex of bone resulting from tumor invasion. If bone invasion is suspected based on MRI, it is important to compare the findings with those of CT during diagnosis (Fig. 6). In oropharyngeal cancer, diagnosis is susceptible to interference by artifacts caused by dental prosthetics (Fig. 7). MRI is the first choice because suprahyoid cervical lymph node metastasis is often difficult to detect on CT. PET is recommended when differentiating recurrence/metastasis and posttreatment change is difficult with CT or MRI.[11, 12, 17)]

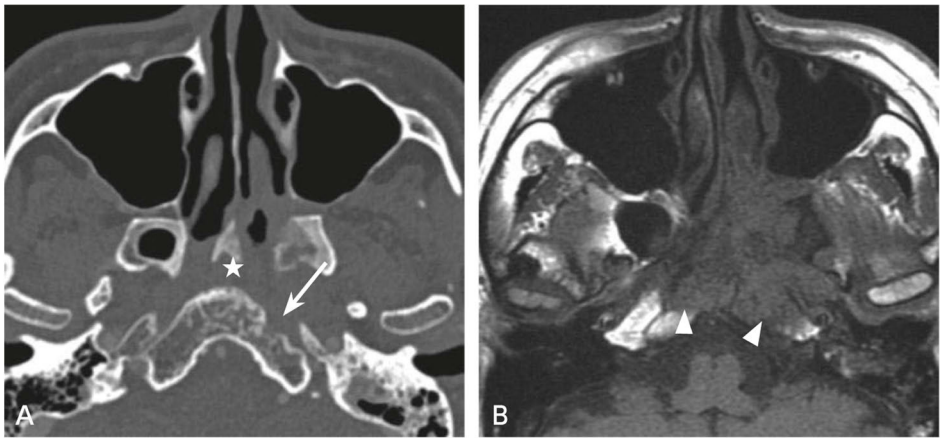

Figure 6. Cranial base invasion of nasopharyngeal cancer

A: Non-contrast CT, bone algorithm; B: MRI, T1-weighted image

In A, the bony cortex of the anterior margin of the clivus, which adjoins the neoplastic area (☆), is ruptured (→). In B, the bone marrow of the clivus shows hypointensity (▷), a finding indicative of extensive bone marrow infiltration.

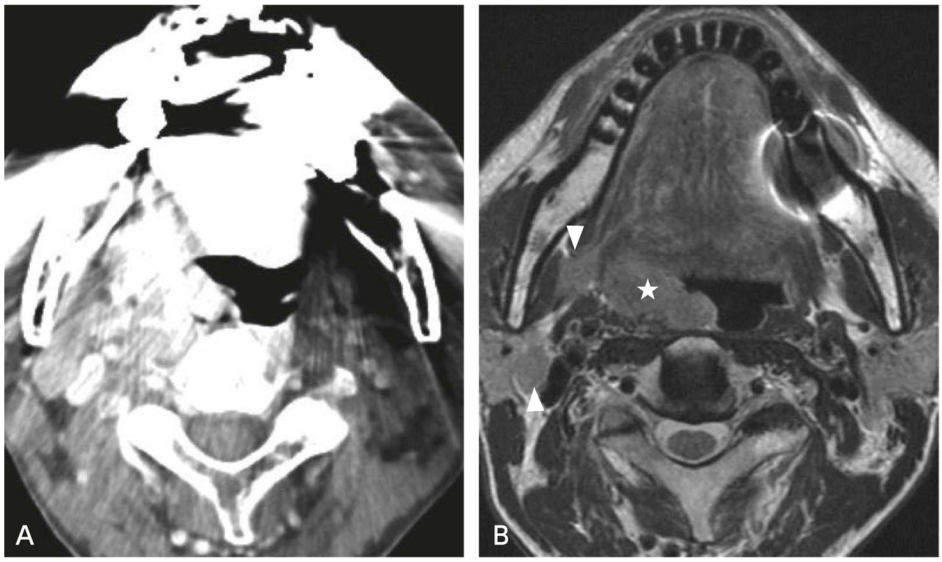

Figure 7. Oropharyngeal cancer and lymph node metastasis

A: Contrast-enhanced CT; B: MRI, contrast-enhanced T1-weighted image

In A, extensive artifacts are present, mainly in the oral cavity, due to a dental prosthetic. Consequently, the tumor cannot be identified. In B, a tumorous lesion is seen in the right palatine tonsil (☆), and a metastatic lymph node (▷) can be clearly observed along with the peripheral soft tissue.

2. Detailed discussion

① CT (Table 9)

(1) Contrast-enhanced CT imaging is performed from the skull base to the superior mediastinum.

(2) Coronal imaging with bone algorithm is useful for evaluating the skull base, and sagittal imaging is useful for observing the retropharyngeal space.

Table 9. Examples of protocols for the upper and middle pharynx: 64-row MDCT system

Imaging Range	Reconstruction Function	Scan Slice Thickness	Reconstruction Slice Thickness	Reconstruction Slice Interval	FOV	WW/WL	Image Processing
From the posterior clinoid process to the inferior extremity of the sternoclavicular joint	For soft tissue	≤ 1.25 mm	≤ 3 mm	Same as at left	160 mm	350/30	Sagittal and coronal planes added as appropriate
Same as above	For bone	≤ 1.25 mm	≤ 3 mm	Same as at left	160 mm	4,000/500	Sagittal and coronal planes added as appropriate

Note 1: Imaging performed under resting respiration

Note 2: Imaging range selected in reference to lateral view of image used to determine location

Table 10. Examples of sequences for the upper and middle pharynx: 3T MRI system, head and neck coil

Imaging Method	Sequence	TR/TE	Slice Thickness	Other
① T2-weighted/transverse	FSE	4,000/85 ms	3 mm	
② T1-weighted/transverse	SE	480/10 ms	3 mm	
③ Fat-suppressed T1-weighted/transverse*	FSE	667/7.8 ms	3 mm	
④ Fat-suppressed T2-weighted/coronal	FSE	4,000/85 ms	3 mm	
⑤ Diffusion-weighted	EPI	6,000/55.3 ms	3 mm	STIR, ADC mapping
⑥ Contrast-enhanced T1-weighted/transverse	SE	480/10 ms	3 mm	Coronal and sagittal planes added as appropriate
⑦ Fat-suppressed, contrast-enhanced T1-weighted/transverse*	FSE	667/7.8 ms	3 mm	

*CHESS recommended

② MRI (Table 10)

(1) A head and neck coil is used for imaging, which is performed over a range that includes the orbit and cavernous sinuses.

(2) Contrast-enhanced imaging is performed for tumors and inflammation.

(3) To obtain good-quality images, the examinee is asked to refrain from coughing or swallowing and to avoid moving his or her tongue as much as possible.

(4) MRI is good for visualizing changes such as tumor soft tissue invasion, bone marrow infiltration, and perineural spread.

Hypopharynx, larynx, and thyroid gland

1. Overview

Non-contrast CT is suitable for detecting foreign bodies such as fish bones. Otolaryngologic emergencies, such as acute epiglottitis and retropharyngeal abscess, are good indications for contrast-enhanced CT.[1, 7] The vast majority of laryngeal cancers and hypopharyngeal cancers are diagnosed before diagnostic imaging is performed. Consequently, the main role of diagnostic imaging is to assess the tumor extension and lymph node metastasis. Artifacts caused by movements such as breathing and swallowing result in poor evaluations with MRI. Contrast-enhanced CT should therefore be given priority (Fig. 8). CT and MRI are performed for thyroid tumors to diagnose the spread of lesions beyond the thyroid gland and to determine the presence or absence of invasion of adjacent organs, such as the trachea, esophagus, and blood vessels, and lymph node metastasis.[18, 19]

2. Detailed discussion

① CT (Table 11)

(1) Non-contrast CT is standard, but contrast-enhanced imaging is necessary if inflammation or a tumor is present.

(2) The imaging range is from the skull base to the superior mediastinum.

(3) Breath-holding is not required during imaging.

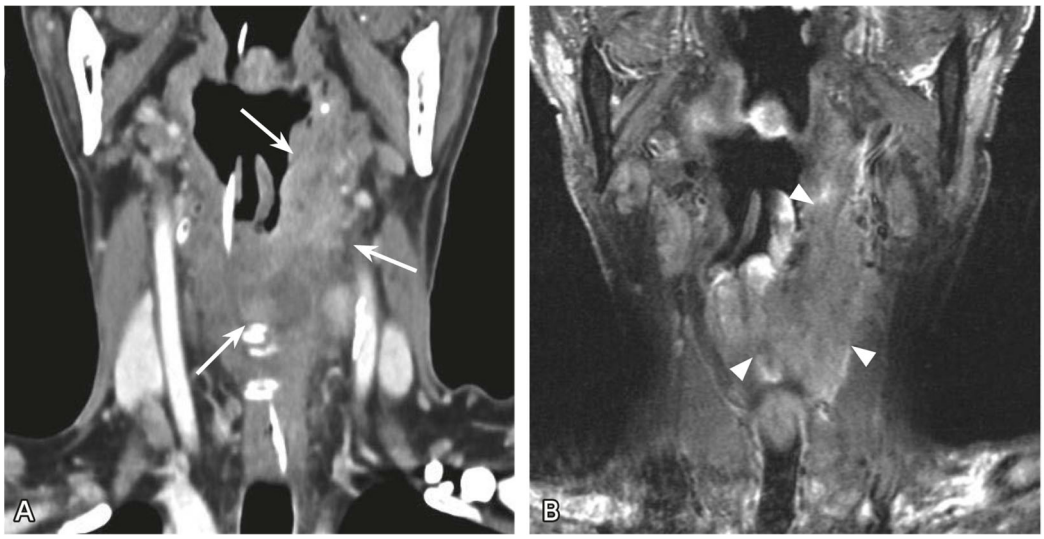

Figure 8. Hypopharyngeal cancer

A: Contrast-enhanced CT, coronal reconstructed image; B: MRI, fat-suppressed, contrast-enhanced, T1-weighted, coronal image

In A, a neoplastic area with non-uniform characteristics is seen progressing hypopharynx anteriorly and superiorly (→). In B, a tumor can be identified (▷). However, there is a marked deterioration in image quality, particularly near pneumatic spaces, resulting from body movement and susceptibility artifacts.

Table 11. Examples of protocols for the hypopharynx and larynx: 64-row MDCT system

Imaging Range	Reconstruction Function	Scan Slice Thickness	Reconstruction Slice Thickness	Reconstruction Slice Interval	FOV	WW/WL	Image Processing
From the posterior clinoid process to the inferior extremity of the sternoclavicular joint	For soft tissue	≤ 1.25 mm	≤ 3 mm	Same as at left	160 mm	350/30	Sagittal or coronal plane and bone algorithm added as appropriate

Note 1: Imaging performed under resting respiration

Note 2: For the thyroid gland, the imaging range extends from the superior margin of the nasopharynx to the inferior extremity of the tracheal bifurcation.

Table 12. Examples of sequences for the hypopharynx and larynx: 3T MRI system, head and neck coil

Imaging Method	Sequence	TR/TE	Slice Thickness	Other
① T2-weighted/transverse	FSE	4,000/85 ms	3 mm	
② T1-weighted/transverse	SE	480/10 ms	3 mm	
③ Fat-suppressed T1-weighted/transverse*	FSE	667/7.8 ms	3 mm	
④ Fat-suppressed T2-weighted/coronal	FSE	4,000/85 ms	3 mm	
⑤ Diffusion-weighted	EPI	6,000/55.3 ms	3 mm	STIR, ADC mapping
⑥ Contrast-enhanced T1-weighted/transverse	SE	480/10 ms	3 mm	Coronal plane added as appropriate
⑦ Fat-suppressed, contrast-enhanced T1-weighted/transverse*	FSE	667/7.8 ms	3 mm	

*CHESS recommended

② MRI (Table 12)

(1) A head and neck coil is used for imaging.

(2) MRI is almost always performed to evaluate local tumor extension not evaluable by CT.

(3) The imaging range is limited to the region of interest, and specifying a smaller FOV is therefore important.

(4) Detailed examination by MRI is useful if invasion of an anterior vertebral muscle/vertebral body is suspected.

Cervical lymph nodes

1. Overview

When observed by CT and MRI, cervical lymph nodes at levels IB (submandibular nodes) and II (superior internal jugular nodes) with a maximum diameter of < 15 mm, minimum diameter of < 11 mm, and other cervical lymph nodes with a minimum diameter of < 10 mm are treated as normal lymph nodes, and larger lymph nodes are treated as enlarged. Rouviere's lymph nodes with a long-axis diameter of ≥ 8 mm and short-axis diameter of ≥ 6 mm are treated as enlarged lymph nodes.[21] At all sites, central necrosis and indistinct borders are considered pathological findings.[22]

With CT, contrast-enhanced imaging is essential. If a contrast-enhanced examination cannot be performed, an alternative modality such as MRI or ultrasonography is considered. Contrast-enhanced imaging is also the rule with MRI. Diffusion-weighted imaging and ADC mapping may be useful for distinguishing between benign and malignant lesions. With contrast-enhanced CT and MRI, indistinct structures derived from hilar fat tissue and changes in the attenuation value or signal inside a node due to central necrosis are examined as possible pathological findings regardless of size.[23-25]

2. Detailed discussion

① CT

A contrast-enhanced examination is standard.

(1) The CT imaging range is from the skull base to the aortic arch.

(2) Coronal plane images are generated by multiplanar reconstruction, with sagittal images added as necessary.

② MRI (Table 13)

(1) A head and neck coil is used for imaging.

(2) T1-weighted imaging, T2-weighted imaging, and contrast-enhanced T1-weighted imaging are standard.

(3) Fat-suppressed T2-weighted imaging is useful for lymph node internal characterization, particularly the detection of colliquative necrosis.

(4) With regard to imaging planes, transverse plane imaging is standard, and coronal imaging is added as necessary.

(5) When fat-suppressed, contrast-enhanced, T1-weighted imaging is performed, non-fat-suppressed, non-contrast-enhanced, T1-weighted imaging is also performed in view of the effects of susceptibility artifacts.

(6) Diffusion-weighted imaging is useful for detecting cervical lymph nodes and diagnosing conditions such as malignant lymphoma.

Table 13. Examples of sequences for the cervical lymph nodes: 3T MRI system, head and neck coil

Imaging Method	Sequence	TR/TE	Slice Thickness	Other
① T2-weighted/transverse	FSE	4,000/85 ms	3 mm	
② T1-weighted/transverse	SE	480/10 ms	3 mm	
③ Fat-suppressed T1-weighted/transverse*	FSE	667/7.8 ms	3 mm	
④ Fat-suppressed T2-weighted/coronal	FSE	4,000/85 ms	3 mm	
⑤ Diffusion-weighted	EPI	6,000/55.3 ms	3 mm	STIR, ADC mapping
⑥ Contrast-enhanced, T1-weighted/transverse	SE	480/10 ms	3 mm	Coronal plane added as appropriate
⑦ Fat-suppressed, contrast-enhanced, T1-weighted/transverse*	FSE	667/7.8 ms	3 mm	

*CHESS recommended

^{18}F-FDG PET/CT imaging[26)]

1. Procedure

^{18}F-FDG is administered intravenously. The dose used is adjusted appropriately depending on the type of system used and the patient's age and weight. Blood glucose is measured immediately before the test. Sixty minutes after administration, whole-body CT and PET imaging is performed using a PET/CT system. Late-phase imaging from 2 hours onward is added as necessary.

2. Important points for testing

As pretreatment, the patient is fasted for at least 4 hours. When the blood glucose level is high, and in some patients with diabetes mellitus, tumor ^{18}F-FDG uptake may decrease, and background uptake may increase, reducing detection performance. In addition, background uptake by tissue such as muscle increases after insulin administration.

Uptake by skeletal muscle increases from before to after ^{18}F-FDG administration, particularly with post-administration exercise (muscular tension and contraction). Consequently, the patient remains at rest after administration.

Because ^{18}F-FDG is excreted mainly by urinary excretion, the patient is asked to urinate immediately before the test, which reduces intravesical radioactivity. Radiation exposure is also reduced by encouraging water intake/diuresis.

Together with an evaluation by visual assessment, the level of uptake is semi-quantitatively evaluated using the standardized uptake value (SUV), which is the uptake ratio for the dose per unit body weight.

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BQ 10 Is CT recommended for adult sinusitis?

Statement

CT is usually unnecessary for uncomplicated acute sinusitis. CT imaging is recommended in the following cases: whether sinusitis is present needs to be determined and the cause identified; an intraorbital or intracranial complication is suspected; surgery is considered; or the presence of a tumorous lesion is suspected.

Background

In the outpatient setting, occasions on which paranasal sinus plain radiography is performed for patients complaining of paranasal sinus-related symptoms are decreasing, and CT is becoming the standard imaging examination. MRI may be added if complications are suspected. The evidence that such an examination process is appropriate is described below.

Explanation

Uncomplicated acute sinusitis is diagnosed based on symptoms, clinical course, and intranasal findings, and imaging examinations are usually unnecessary.[1)] In a comparison of endoscopy and plain radiography, Berger et al. found that the diagnostic performance of the 2 examinations was comparable, and they recommended endoscopy as the first choice.[2)] A negative endoscopy examination or the presence of strong symptoms may be an indication for an imaging examination. Outpatient examinations are screening tests, and high sensitivity is required. However, the sensitivity of plain radiography is low. Consequently, CT is the standard when imaging is indicated for acute sinusitis.[3-5)]

The sensitivity and specificity of plain radiography for chronic sinusitis are also lower than the sensitivity and specificity of endoscopy.[6)] CT is excellent for bone evaluation and can readily be used to evaluate mucosal thickening. It is therefore the standard examination for sinusitis.[4, 5, 7-10)] CT can also be used to evaluate conditions such as anatomical variations that cause sinusitis, odontogenic maxillary sinusitis, and fungal sinusitis.[4, 11)] Consequently, when CT can be performed, it is recommended that plain radiography be omitted, and that CT be performed from the start.[12)] In preoperative evaluations before endoscopic surgery, CT is excellent for visualizing important anatomical structures (e.g., the air cell/osteomeatal unit, ethmoidal foramen, optic canal, and internal carotid artery), and its use is recommended for this purpose.[1, 4, 8, 12)] Although there is insufficient evidence regarding the usefulness of a contrast medium, such use is unnecessary in chronic sinusitis, but it can be considered if a tumor is suspected. Cone-beam CT is a method of CT by which X-rays are emitted in a conical pattern and detected by a 2-dimensional detector. Cone-beam CT was commercialized in 2001. Compared with multi-row detector CT, it is inexpensive, compact, and involves a low radiation dose. Consequently, it can be a potent

tool for diagnosing sinusitis. However, it provides low tissue contrast, making it unsuitable for evaluating soft tissue lesions, such as those seen with the spread of inflammation outside the sinus.[13, 14)]

With MRI, bone visualization is inferior to that provided by CT, and the imaging takes time. MRI is therefore unlikely to be the first imaging examination used for sinusitis.[7, 8)] However, MRI provides better tissue contrast than CT and is therefore recommended when inflammation is suspected of having spread intracranially and intraorbitally.[1, 4, 8, 9)] If invasive fungal sinusitis is suspected, MRI should be considered to evaluate the spread of inflammation to outside the sinus. In addition, MRI facilitates the differentiation of fluid accumulation and tumors. It is therefore also useful when a tumorous legion such as papilloma or cancer is suspected of being the cause of sinusitis.[7, 10, 11)] When an intracranial/intraorbital complication or tumor is suspected, fat-suppressed, contrast-enhanced T1-weighted imaging is preferred.

In summary, diagnostic imaging is unnecessary for uncomplicated acute sinusitis. Plain radiography can be considered in circumstances where CT cannot be performed. However, scientific evidence of its usefulness for diagnosis has not been established. CT imaging is recommended as the standard examination in the following cases: whether sinusitis is present needs to be determined and the cause identified; an intraorbital or intracranial complication is suspected; surgery is considered; or the presence of a tumorous lesion is suspected. MRI is recommended when intracranial or intraorbital complications, a tumorous lesion, or invasive fungal sinusitis is suspected.

Search keywords and secondary sources used as references

PubMed was searched using the following keywords: plain radiography, paranasal sinus, CT, and MRI. The period searched was through the end of June 2019.

In addition, the following was referenced as a secondary source.

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BQ 11 Is MRI recommended for determining the T stage of head and neck cancer?

Statement

The strength with which MRI is recommended for the T staging of head and neck cancer varies depending on the subsite. It is recommended for nasopharyngeal and oropharyngeal cancer, but it is not strongly recommended for laryngeal or hypopharyngeal cancer.

Background

The most accurate possible staging by diagnostic imaging is required to determine an appropriate treatment plan for head and neck cancer. With diagnostic imaging for the T staging of head and neck cancer, MRI is thought to provide diagnostic performance comparable to that of CT. However, the recommendation grade for MRI varies depending on the subsite. MRI is clearly superior for evaluating nasopharyngeal cancer, oral cavity cancer, or oropharyngeal cancer (particularly in patients for whom evaluation by CT is difficult due to artifacts). However, in laryngeal and hypopharyngeal cancer, due to low temporal resolution, image quality deterioration resulting from body movements such as breathing and swallowing is problematic. The basis for the statement regarding nasopharyngeal, oropharyngeal, oral cavity, laryngeal, and hypopharyngeal cancer in the BQ is summarized in the following.

Explanation

A meta-analysis found that MRI showed higher accuracy than CT in the T staging of nasopharyngeal cancer,[1)] and MRI is strongly recommended for this purpose.[1-3)] With its high tissue contrast, MRI is also superior to CT for evaluating extension to the adjacent pharyngeal space, cranial base, intracranial area, and sphenoid sinus.[2)] MRI shows high sensitivity and specificity for skull base invasion (particularly high sensitivity compared with CT).[4)] MRI is also superior to CT in the evaluation of intracranial invasion.[5)] In addition, MRI is useful for evaluating the involvement of areas such as anterior vertebral muscle (T2), cervical vertebrae and pterygoid process (T3), and parotid gland (T4), which were items added in the 6th edition of the General Rules for Clinical Studies on Head and Neck Cancer (secondary source 1).

In oral cavity cancer, MRI is superior to CT for evaluating soft tissue and bone marrow infiltration.[6-10)] MRI is generally superior to CT for visualizing soft tissue and is little affected by artifacts from metal in the oral cavity. It is therefore recommended for evaluating the tumor extension of the primary lesion.[6, 8, 10, 11)] Tongue cancer is the most common form of oral cavity cancer in Japan, and the depth of invasion (DOI) is important for the T staging of tongue cancer. MRI has shown a strong correlation with pathological DOI, and the DOI measured with T2- and T1-weighted imaging has been found to be 2 to 3 mm deeper than the pathological DOI.[12-14)] In evaluating jaw bone invasion in lower gingival cancer, MRI is more sensitive but less specific than CT,[8, 9, 15-18)] and its diagnostic accuracy rate is comparable to that of CT.[17)] CT is useful

for evaluating bone cortex invasion and MRI for evaluating invasion of the bone marrow.[11] MRI is more accurate than CT for evaluating soft tissue and bone invasion in oropharyngeal cancer anatomically adjacent to the oral cavity, [6, 7] and it is little affected by artifacts from metal in the oral cavity. MRI is therefore recommended for this purpose.

From the perspectives of test efficiency, cost-effectiveness, and diagnostic accuracy, CT is the first choice for T staging in hypopharyngeal and laryngeal cancers. Although taking MRI findings into account has been found to enable more accurate T staging,[19, 20] the diagnostic accuracy rates of CT and MRI have been found not to differ significantly.[19, 20] Although MRI is used for T staging in clinical practice, detailed evaluation with MRI is often difficult due to susceptibility artifacts caused by adjacent air. CT is always performed in patients with advanced disease and suspected cartilage invasion corresponding to stage T3 or T4a. However, no reported investigations have compared the diagnostic performance of CT alone and CT combined with MRI. For CT, the reported sensitivity and specificity for cartilage invasion have ranged from 0.50 to 0.96 and from 0.60 to 1.00, respectively.[20-25] For MRI, they have ranged from 0.88 to 1.00 and from 0.75 to 1.00, respectively.[20-22, 24, 26-28] Thus, MRI and CT are comparable in specificity, and MRI is higher in sensitivity than CT. However, if cartilage invasion can be definitively ruled out by CT, the addition of MRI is unnecessary. If cartilage invasion is suspected based on CT, MRI is not strongly recommended in view of its low test efficiency. The addition of MRI is considered only if definitively diagnosing cartilage invasion is difficult with CT and affects treatment selection. High sensitivity and specificity have been reported for both MRI and CT in the evaluation of pre-epiglottic and paraglottic space invasion corresponding to stage T3.[20, 29] However, the high sensitivity of MRI can result in overestimates in early stage glottic cancer.[22] Overestimation of paraglottic space invasion resulting from inflammatory changes is also a problem for MRI.[30, 31] Consequently, CT is the standard choice. For anterior vertebral space invasion corresponding to state T4b, the negative predictive values of both MRI and CT are high, and both therefore contribute to preoperative evaluation.[32] In thyroid gland invasion corresponding to stage T4a, false-positives are common with MRI, and it therefore lacks reliability.[33]

Search keywords and secondary sources used as references

PubMed was searched using the following keywords: head and neck cancer, stage, nasopharyngeal carcinoma, oral cavity carcinoma, imaging, oropharyngeal carcinoma, laryngeal cancer, and hypopharyngeal carcinoma.

In addition, the following was referenced as a secondary source.

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BQ 12 Is CT recommended for determining the N stage of head and neck cancer?

Statement

CT is the standard examination and recommended for determining the N stage of head and neck cancer.

Background

The N staging of head and neck cancer is important for determining a treatment strategy and predicting prognosis. Diagnosing cervical lymph node metastasis involves evaluating size, morphology, and internal and margin characteristics. Modalities such as ultrasound, CT, MRI, and PET are used for this purpose, and each has advantages and disadvantages. The basis of CT's rank as a first-line standard examination for the N staging of head and neck cancer is summarized below.

Explanation

Various imaging modalities are used to diagnose cervical lymph node metastasis in head and neck squamous cell carcinoma. Curtin et al. reported comparable sensitivity and specificity for CT and MRI in detecting lymph node metastasis.[1)] A meta-analysis by Wu et al. showed that, in a comparison of MRI and CT, sensitivity was 67.4% and 64.2%, respectively, and specificity was 78.7% and 75.4%, respectively. In a comparison of MRI and PET, sensitivity was 66.5% and 66.2%, respectively, and specificity was 76.6% and 81.4%, respectively. They reported finding no significant differences between the modalities.[2)]

In the morphological diagnosis of cervical lymph node metastasis, aspects such as lymph node size, morphology, internal characteristics, and margin characteristics must be evaluated.[3)] Various criteria are used to assess lymph node metastasis size. However, the following criteria are generally used: one in which a maximum cross-sectional diameter of 15 mm for the superior internal jugular nodes and submandibular nodes and ≥ 10 mm for the other lymph nodes is considered significant and another in which a minimum cross-sectional diameter of 11 mm for the superior internal jugular nodes and ≥ 10 mm for the other nodes is considered significant. Adding information on morphology and internal and margin characteristics to these criteria increases sensitivity and diagnostic performance. Consequently, evaluation by contrast-enhanced CT is required when possible, except in patients with a contrast medium allergy or decreased kidney function (dialysis patients excluded).

Internal non-uniformity, such as that resulting from necrosis in a lymph node, is the imaging finding with the highest specificity, and evaluation by MRI, which provides high tissue contrast, is considered useful for detecting such non-uniformity. King et al. found MRI to be comparable to contrast-enhanced CT with respect to its performance in detecting nodal necrosis with lymph node metastasis of head and neck cancer.[4)] Sumi et al. reported that, when used to evaluate internal characteristics such as cancer foci, necrosis, and keratinization seen in metastatic foci with lymph node metastasis of head and neck cancer,

MRI was superior to contrast-enhanced CT for metastatic small lymph nodes with a short-axis diameter of < 10 mm.[5] Apparent diffusion coefficient (ADC) values for lymph node enlargement obtained in MRI diffusion-weighted imaging have been found to be useful for benign-malignant differentiation of lymph nodes. Moreover, ADC values for lymph node metastasis have been found to be significantly lower than those for benign lymph node enlargement.[6] In addition, a meta-analysis regarding lymph node metastasis differentiation found that quantitative assessment using ADC values aided in diagnosis.[7] These results indicate that there is room to consider the addition of MRI for determining the N stage of head and neck cancer in patients who cannot undergo contrast-enhanced CT. It should be noted, however, that MRI image quality and the values used in quantitative assessments depend on the systems and imaging methods used at each facility.

Ultrasound and PET/CT have also been reported to be useful for diagnosing lymph node metastasis in head and neck cancer.[3, 8] However, contrast-enhanced CT enables images of high spatial resolution to be obtained over an extensive range in a short time. It is therefore often performed both to evaluate primary lesions and to screen for distant metastasis. It is therefore appropriate to consider contrast-enhanced CT the standard for determining the N stage of head and neck cancer.

Search keywords and secondary sources used as references

PubMed was searched using the following keywords: cervical lymph node metastasis, head and neck cancer, CT, MRI, and PET/CT. The period searched was through the end of June 2019.

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BQ 13 Is PET recommended for determining the M stage of head and neck cancer?

Statement

PET is the standard examination and recommended for determining the M stage of head and neck cancer.

Background

The number of facilities that perform PET for the preoperative staging of head and neck cancer is increasing, and it is becoming established as an essential modality, particularly for performing highly accurate staging. The basis for considering PET useful for determining the M stage of head and neck cancer is summarized in the following.

Explanation

The importance of PET is that it can easily perform whole-body screening, and its strength is therefore particularly evident in determining the M stage. It is generally performed in patients for whom staging and the diagnosis of metastasis and recurrence cannot be definitively established with other examinations and diagnostic imaging modalities. However, given the usefulness of visual diagnosis with PET, it is also generally recommended for determining the M stage of head and neck cancer. In an investigation of staging and treatment plan changes in 52 patients with head and neck squamous cell carcinoma by Jorgenson et al., the addition of PET/CT to CT/MRI resulted in TNM stage changes in 0.0%, 23.1%, and 3.8%, respectively, and changes in stage and treatment plan in 9.6% and 5.8%, respectively.[1)] However, there have been warnings that PET/CT delays the start of treatment and increases its cost. In addition, the performance of FDG-PET/CT in detecting distant metastasis and simultaneous cancer in patients with laryngeal cancer, oral cavity cancer, and pharyngeal cancer was reported to be significantly better than that of chest radiography combined with head and neck CT.[2)] Similarly, the performance of FDG-PET/CT in detecting distant metastasis and simultaneous cancer in patients with laryngeal cancer, oral cavity cancer, and pharyngeal cancer was significantly better than that of chest radiography combined with cervical MRI and chest CT combined with cervical MRI.[3)] Since FDG-PET/CT came into clinical use, the frequency of distant metastasis detection has increased. Moreover, FDG-PET/CT is considered useful in screening for simultaneous cancer, which has a stronger effect on prognosis than the primary cancer.

Lymph node metastasis can also be evaluated with PET/CT. A meta-analysis by Kim et al. of 18 articles on diagnostic performance for lymph node metastasis with the addition of PET/CT in patients with clinical N0 (cN0) head and neck squamous cell carcinoma found that sensitivity and specificity were 58% and 87%, respectively, in a patient-based analysis, 67% and 85%, respectively, in a neck side-based analysis, and 53% and 97%, respectively, in a level-based analysis. The authors therefore concluded that PET/CT is an examination with excellent specificity.[4)] Li et al. performed a meta-analysis of 8 articles and reported the

following regarding diagnostic performance with the addition of PET/CT in patients with cN0.[5] Sensitivity, specificity, the odds ratio, positive likelihood ratio, and negative likelihood ratio were, respectively, 0.61 (95% CI, 52% to 69%), 0.74 (95% CI, 68% to 78%), 9.62 (95% CI, 2.49 to 37.22), 3.22 (95% CI, 1.55 to 6.71), and 0.42 (95% CI, 0.24 to 0.37). The authors indicated that, although the diagnostic performance of PET/CT was not better than that of CT/MRI, that was attributable to the high heterogeneity of the study designs.[5] In an investigation by Lee et al. in 39 patients with head and neck squamous cell carcinoma, the sensitivity of PET/CT, CT/MRI, and PET/CT combined with CT/MRI for disease classified as cN0 based on palpation was 65.7%, 57.1%, and 65.7%, respectively. The authors concluded that there were no significant differences in sensitivity between the imaging methods.[6] Although there is debate regarding the usefulness of PET/CT in patients with cN0, it should be combined with other modalities to comprehensively evaluate the lymph nodes.

Search keywords and secondary sources used as references

PubMed was searched using the following keywords: head and neck cancer and PET/CT. The period searched was from June 2015 to the end of June 2019.

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BQ 14 Are CT and MRI recommended for the post-treatment follow-up of head and neck cancer?

Statement

CT and MRI are the standard examinations and are recommended for the post-treatment follow-up of head and neck cancer.

Background

Treatments for head and neck cancer include surgery, radiation therapy, and chemoradiotherapy. The optimal treatment is selected according to the primary site, pathological diagnosis, and disease stage. Early detection of post-treatment recurrence is an important prognostic factor. However, methods of follow-up vary between facilities, and the diagnostic imaging modalities that are selected are also varied. The reasons why CT and MRI are the standard examinations for post-treatment follow-up of head and neck cancer are summarized below.

Explanation

In post-treatment follow-up of head and neck cancer, adequately determining postoperative status by inspection or endoscopy alone is often difficult, and imaging modalities such as CT or MRI are necessary for the early detection of recurrence. Recurrence after treatment for head and neck cancer nearly always occurs within 2 years after the treatment.[1, 2)] The 2019 edition of the NCCN guidelines for head and neck cancer recommend periodic examination once every 1 to 3 months in the first year after surgery, once every 2 to 6 months in the 2nd year, once every 4 to 8 months in the 3rd to 5th years, and subsequently once a year. In addition, they recommend performing the baseline imaging examination for follow-up within 6 months after treatment.

After radiation therapy or chemoradiotherapy for head and neck cancer, the treatment response of the primary tumor and cervical lymph node metastases is evaluated, and whether to perform resection for the residual tumors or neck dissection is determined. According to the NCCN guidelines, inspection is performed 4 to 8 weeks after radiation therapy or chemoradiotherapy. If an increase in size or the presence of residual tumors is suspected for the primary tumor and cervical lymph node metastases, CT, MRI, or PET is performed. If a treatment response is seen, either CT or MRI at 8 to 12 weeks or PET at 12 weeks or later is recommended. If residual cervical lymph node metastases are seen with these examinations, neck dissection should be performed. If the PET examination is negative, the likelihood of residual tumors is low, and subsequent imaging is not recommended.

With regard to the imaging examinations used at baseline and during follow-up, although contrast-enhanced CT is generally used, contrast-enhanced MRI is useful for tumors near the skull base, such as nasopharyngeal and paranasal sinus tumors, salivary gland tumors, and tumors suggestive of bone

marrow, skull base, intracranial invasion or perineural spread.[1, 3] The baseline examination should be performed at a time when postoperative reactions such as edema and inflammation have subsided and no recurrence is seen. CT and MRI are generally performed 6 to 8 weeks after treatment.[1, 4]

Many investigations of the performance of CT and MRI in diagnosing recurrence and residual tumors have used ADC values obtained by diffusion-weighted MRI. The ADC values for recurrence and residual tumors are significantly lower than those for postoperative scar tissue, and their reported sensitivity and specificity have ranged from 90.1% to 94% and from 82.5% to 83.3%, respectively.[5, 6] Consequently, the addition of diffusion-weighted imaging to normal morphological imaging enables more accurate internal characterization of lesions.

In addition, many investigations have used PET, which has been reported to be an excellent examination for diagnosing recurrence and residual tumors. The sensitivity and specificity of PET have ranged from 72.3% to 92% and from 82.3% to 87%, respectively.[7, 8] However, a disadvantage of PET is the high rate of false positives early after treatment completion due to conditions such as edema and inflammation. Although the timing of PET varies somewhat depending on the report, 12 weeks after treatment or later is considered preferable. Although PET is useful for diagnosing recurrence and residual tumors, it poses problems for follow-up, such as problems related to its indications, timing, intervals, cost-effectiveness, and radiation exposure. Consequently, it can be considered when diagnosis proves difficult with CT or MRI.

Search keywords and secondary sources used as references

PubMed was searched using the following keywords: head and neck cancer, post treatment, follow up, diagnostic imaging, CT, and MRI. The period searched was through the end of June 2019.

In addition, the following was referenced as a secondary source.

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BQ 15 Is MRI recommended for the qualitative diagnosis of parotid tumors?

Statement

MRI is the standard examination and recommended for the qualitative diagnosis of parotid tumors.

Background

Approximately 80% of parotid tumors are benign, and ≥ 90% of those are pleomorphic adenomas and Warthin's tumors. Consequently, in addition to broad categorization as benign and malignant, differentiating pleomorphic adenomas (resection is recommended, including the capsule) and Warthin's tumors (enucleation or watchful waiting is sufficient) is important in diagnosing parotid tumors. Ultrasound-guided fine-needle aspiration cytology (FNAC) is an established diagnostic method with a diagnostic accuracy rate higher than 85%. However, diagnosing tumors located in the deep lobe is difficult with FNAC, and there is a risk of tumor seeding and infarction associated with the technique. Consequently, MRI, which is noninvasive and provides excellent tissue contrast, is widely used for the qualitative diagnosis of parotid tumors. The reasons why MRI is the standard imaging examination for the qualitative diagnosis of parotid tumors are summarized below.

Explanation

The main findings suggestive of malignant tumors with conventional MRI, which does not include diffusion-weighted imaging or dynamic contrast-enhanced MRI, are indistinct margin characteristics and lower signal intensity than the parotid gland tissue on T2-weighted images.[1)] The former finding overlaps with that for inflammatory masses, and the latter overlaps with that for Warthin's tumor. However, comparisons with FNAC have shown their diagnostic accuracy rates to be comparable.[2, 3)] A meta-analysis by Liang et al. found that sensitivity and specificity, as measures of diagnostic performance in differentiating benign and malignant lesions based on conventional MRI findings, were 76% and 83%, respectively. Adding the ADC values of diffusion-weighted imaging and the time-signal intensity curve (TIC) analysis of dynamic contrast-enhanced MRI to conventional MRI increased sensitivity and specificity to 86% and 90%, respectively.[4)] With diffusion-weighted imaging, which is incorporated as the standard imaging method in this guideline (p. 76), the ADC values of pleomorphic adenomas are significantly higher than those of malignant tumors and Warthin's tumors, which is useful for differential diagnosis. However, the ADC values for Warthin's tumors and malignant tumors overlap.[5-7)] The TIC patterns often seen with dynamic contrast-enhanced MRI are a gradual increase for pleomorphic adenomas, a rapid increase and rapid decrease (peak reached within 120 seconds and washout rate of ≥ 30% after 300 seconds) for Warthin's tumors, and a rapid increase and gradual decrease for malignant tumors. These patterns are useful for differentiating benign from malignant tumors and diagnosing Warthin's tumors.[6, 7)]

With perfusion imaging using arterial spin labeling (ASL), which does not require a contrast medium, the tumor-to-parotid gland signal intensity ratio of Warthin's tumors is higher than of malignant tumors and of pleomorphic adenomas, which is useful for diagnosing Warthin's tumor.[8] Classic observations such as lobulated shape for pleomorphic adenomas and inferior pole and multiple bilateral occurrences in the parotid glands for Warthin's tumors are also important in clinical practice.

With regard to CT, because its tissue contrast is low, it is lacking in usefulness with respect to the qualitative diagnosis of parotid tumors. However, CT is useful when diagnosing extent is required, as in the case of lymph node metastasis or bone cortex invasion.[9] Fat-suppressed, contrast-enhanced, T1-weighted imaging is recommended for evaluating perineural spread along nerves such as the 3rd branch of the trigeminal nerve (mandibular nerve) or facial nerve.[9]

It is therefore appropriate to consider MRI the standard examination for the qualitative diagnosis of parotid tumors.

Search keywords and secondary sources used as references

PubMed was searched using the following keywords: MRI, parotid, and diagnostic accuracy. A filter was applied to limit the search to English-language reports with human subjects. The period searched was from January 1, 2005 to December 31, 2019. Hits were obtained for 55 articles, which were screened based on their titles and abstracts. The full text of 17 articles was then evaluated. Of these, 8 articles were used as reference articles for MRI diagnosis. In addition, a search was performed using "parotid gland" and "imaging review" as the keywords, with a filter applied that limited the search to review articles in English, and the resulting articles were used.

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BQ 16 Is I-131 internal radiation therapy recommended in young patients with thyroid carcinoma?

Statement

I-131 internal radiation therapy is safe, useful, and recommended in young patients with thyroid carcinoma.

Background

Slightly less than 15% of well-differentiated thyroid carcinomas occur in individuals aged 18 years or less. It is often more advanced in prepubescent patients than in adolescents, and the recurrence rate is higher in prepubescent patients than in adult patients. The usefulness of I-131 internal radiation therapy in young patients with thyroid carcinoma was examined.

Explanation

I-131 internal radiation therapy is widely used in young patients after total thyroidectomy. It has been found to be useful for treating residual tumors and thyroid bed ablation.[1-5] Although adverse reactions such as nausea, vomiting, and mild bone marrow suppression may occur, internal radiation therapy particularly for lesions up to 1 cm in diameter at intervals of 6 to 12 months for a total dose of 18.5 to 37 GBq (500 to 100 mCi) is considered a relatively safe treatment.[2] However, there have been almost no reports of studies comparing it with a group that has not received internal radiation therapy. In addition, because there may be a risk of secondary carcinogenesis resulting from the radiation exposure, periodic follow-up is considered necessary.[3-5]

Search keywords and secondary sources used as references

PubMed was searched using the following keywords: differentiated, thyroid carcinoma, radioiodine, therapy, and childhood. Five articles were selected from the results.

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