ORIGINAL RESEARCH ARTICLE

Multi Detector Computed Tomography Evaluation of Neck Masses in Adults

Sachin Bagale[1], Vasudha Agarwal[2], Vaibhav Dethe[3]

[1]Associate Professor, [2]Senior Resident, [3]Assitant Professor, Byramjee Jeejeebhoy Medical College and Sassoon Hospital, Pune, India

Corresponding author: Dr Vasudha Agarwal, Flat No B/2, Shanti Kunj Society,Opp GPO. Sadhu Vaswani Road, Pune, India

How to cite this article: Sachin Bagale, Vasudha Agarwal, Vaibhav Dethe. Multi detector computed tomography evaluation of neck masses in adults. International Journal of Contemporary Medicine Surgery and Radiology. 2017;2(4):127-132.

ABSTRACT

Introduction: Neck imaging has always been a diagnostic challenge. Multi-Detector row Computed Tomography is an important imaging modality for characterization and presurgical evaluation of neck masses. The imaging features of different neck lesions were evaluated to determine their benign/malignant nature and study their demographic profile. Few extremely rare/unique cases were also included in this study. Study was done for anatomical localization and characterization of neck masses with the help of Multi-detector row computed tomography and to classify and determine the occurrence of neck masses in different age/gender groups.

Material and Methods: A total number of 80 adult patients (>=13 years) with suspected neck masses were studied in our department over a period of 18 months. Contrast enhanced CT was done using a Siemens Somatom (64x2) slice Multidetector CT scan machine(manufactured in Germany). Post processing techniques (like volume rendered techniques) were applied wherever useful.

Results: The findings on CT were conclusive in 90% of cases. Enhancement patterns and presence/absence of bony invasion were found to be more specific in differentiating benign/malignant nature. A variety of cases ranging from thyroglossal duct cyst to florid recurrent oral carcinoma cases were observed. Few unique cases like hemangioma involving the uvula, vallecular cyst and Kimura's disease were also noted.

Conclusion: Multi-detector row computed tomography is a sensitive diagnostic tool for diagnosing neck masses and differentiating between benign and malignant lesions with high accuracy. The extent of pathology with local/ contiguous spread predicted by CT examination was conclusive.

Key words: Benign, Gingivobuccal, Hemangioma, Kimura's, Larynx, Malignant, Parotid, Thyroid, Uvula, Valleculae

INTRODUCTION

Computed tomography is often the first diagnostic imaging examination performed in patients in whom the presence of a head/neck mass is either evident or suspected. It helps to evaluate the true extent of disease to best determine surgical and therapeutic options. This process includes evaluation of the size, location and extent of tumour infiltration into surrounding vascular and visceral structures. Multi-slice spiral computed tomography (CT) provides volumetric helical data, thereby permitting optimal multiplanar and 3D reconstructions. Rapid scan acquisition reduces motion artefacts, as well as permits phonation studies.

Current study was done with objectives for anatomical localization and characterization of neck masses with the help of Multi-detector row computed tomography and to classify and determine the occurrence of neck masses in different age/gender groups.

MATERIAL AND METHODS

This was a prospective study of neck lesions in adult patients where 80 patients with palpable and non-palpable suspected masses were studied. Siemens Somatom definition AST 65983 mmwp-70527 (64x2) slice multidetector CT scan machine (manufactured in Germany) was used to scan patients. MEDRAD STELLANT 105.2 SH pressure injector was used for contrast administration.

Inclusion Criteria: Patients in the age group of 13-80 years of age with palpable and suspected non palpable neck masses.

Exclusion Criteria: Pregnant patients or those with contraindications to contrast study i.e. serum creatinine>1.5 or any known/previous history of allergy.

Ethical Clearance: The study was approved by the ethics

Feature	Benign (Total=33)		Malignant (Total=47)	
	Number	Percentage (%)	Number	Percentage (%)
Homogeneous enhancement	27	80	0	0
Heterogeneous enhancement	3	9	47	100
Necrosis	2	<1	41	82
Bony invasion	0	0	29	60
Vascular invasion	2	<1	13	28
Trans spatial invasion	9	27	35	75
Lymphadenopathy	16	48	41	87

Table-1: Tabulation of lesions according to lesion characteristics

committee of the institution where this study was carried out.

STATISTICAL ANALYSIS

Tabulation of data was done to study the benign and malignant characteristics which helped in deciding the benign/malignant nature and diagnosis of each neck lesion. Various bar charts were constructed to determine the occurrence of different neck lesions and their predilection according to age and gender.

RESULTS

Certain imaging parameters, such as type of enhancement (homogeneous/heterogeneous), presence or absence of bony/vascular/transspatial invasion were used to define each of the lesions in this study. On this basis of above characteristics, the lesions were classified as benign or malignant.

Almost all benign lesions showed homogeneous enhancement without any significant necrosis. The benign lesions did not show any significant involvement of adjacent structure be it bony or vascular ones. Only infective lesions like large lymph nodal masses showed thrombosis of adjacent internal jugular veins as well as involvement of more than one deep neck spaces.

All malignant lesions showed heterogeneous contrast enhancement with majority showing necrosis. A significant number of malignant lesions showed bone involvement and extension into adjacent spaces.

A composite table describing the importance of various characteristics to define the benign/malignant nature of neck masses is shown in Table 1.

In this study, majority of benign lesions of the head and neck region including the inflammatory, congenital and vascular causes were below the age of 60 years. Whereas, almost all the malignant lesions of head and neck region in this series were above the age of 40 years except for one case of lymphoma in pharyngeal mucosal space which was diagnosed in a 20 years old male. Overall the major age group in this study was 51-60 years.

DISCUSSION

Among the neck lesions, the most common lesions encountered were carcinoma of oral cavity followed by laryngeal carcinoma.

A study done by Ozkiris M. et al[2] also showed that in neck masses, neoplasms should be considered in older adults and inflammatory and congenital masses in children and young patients. In the present study, male predominance of malignant lesions was detected. This could be attributed to the smoking and alcohol habits. A study done by Abhinandan Bhattajaree et al[3] also showed a male preponderance of malignant lesions in neck.

Oral cancers: They form the major chunk of the cancers presenting to our institute, corresponding to the age adjusted incidence in India being 20 per 100,000 populations.

The oral cavity is divided into a central part "the oral cavity proper" and a lateral part "the vestibule". The oral cavity proper consists of the central tongue, the roof formed by the hard palate, the lateral walls by the upper and lower alveolus covered by gingival mucosa, and the floor which is chiefly formed by the mylohyoid muscle. The vestibule is a cleft lined by the buccal mucosa laterally, superiorly and inferiorly by reflections of the buccal mucosa onto the mandible and maxilla, respectively, referred to as the upper and lower gingivobuccal sulci (GBS), the gingival mucosa medially, the lips anteriorly and leads to the retromolar trigone (RMT) posteriorly.

Gingivobuccal squamous cell carcinoma (SCC) includes those arising from the buccal mucosa, the gingival mucosa covering the upper and lower alveolus and from the gingivobuccal sulci (together called the gingivobuccal complex). SCC of the lower gingivobuccal complex are the most common oral cancers in the Indian subcontinent due to tobacco chewing and have been described as the " Indian oral cancer".[4]

CT and Magnetic resonance imaging (MRI) perform comparably for assessment of extent of oral carcinoma.[5,6] CT is preferred for evaluating bone erosion.[7,8] Contrast-enhanced CT combines the advantages of speed of scanning and the ability to use the "puffed cheek" technique for imaging gingivobuccal and RMT cancers.

Bone erosion by SCC is an adverse prognostic criterion and requires some form of mandibular resection, either marginal or segmental mandibulectomy. Subtle cortical erosions were best detected with CT. CT has been

found to have the highest specificity (87%) while single photon emission CT (SPECT) and MRI had the highest sensitivity (96-97%).[9–13] Two studies have also evaluated CT and found a sensitivity of 82.6% and specificity of 86.9% for mandibular invasion.

The findings of osseous involvement in our cases included cortical erosions adjacent to the primary lesion, aggressive periosteal reaction, abnormal attenuation in bone marrow and pathologic fractures.

In the recent literature, combined imaging with PET and CT has been reported to be a highly sensitive technique for detection of recurrence of head and neck cancer in the post-treatment setting.[14,15] An imaging finding seen after neck dissection in cases of oral carcinoma recurrence in our study was an area of soft-tissue attenuation surrounding the carotid sheath completely at CT.[16]

Other CT imaging findings of early reactions to radiation therapy observed were thickening of the skin and platysma, reticulation of the subcutaneous fat, edema and fluid in the retropharyngeal space, increased enhancement of the major salivary glands, thickening and increased enhancement of the pharyngeal walls and thickening of the laryngeal structures. On the other hand, late reactions to radiation therapy included atrophy of the salivary glands and thickening of the pharyngeal constrictor muscle, platysma, and skin.

Tumors typically recur within the first 2 years after treatment. The most common locations for tumor recurrence are in the operative bed and at the margins of the surgical site. Tumor recurrence is identified as a slightly expansile lesion in the operative bed or as progressive thickening of soft tissues deep to the flap.[16–20] CT demonstrated recurrence as an infiltrating slightly hyper attenuating mass with enhancement, with or without bone destruction.[16–18,20] Tumor recurrence has attenuation similar to that of muscle.

A male predominance was seen in our cases of oral cancer, which was probably due to tobacco abuse being more common in males. Most of the cases belong to the age group of 51-60 yrs. The majority of the oral carcinoma cases arose from the gingivobuccal sulcus and extended to involve the retromolar trigone. There was predominant heterogeneous enhancement with significant bony invasion. There was spread to adjacent neck spaces like masticator space and parapharyngeal space in some advanced cases.A significant number of patients came with florid cases of recurrence of oral carcinoma which were invasive on imaging.

Laryngeal carcinoma: It has an incidence that ranges from 2.5 to 17.2 per 100,000 per year and represents approximately 3% of new malignancy diagnosed annually worldwide. Ninety percent of laryngeal malignancy is due to squamous cell carcinoma with lymphoma being the second most frequent diagnosis.

Imaging provides important information concerning nodal metastasis, systemic metastasis, the presence of synchronous tumour and recurrent disease. Critical to the radiological evaluation of laryngeal carcinoma is an understanding of the imaging anatomy, patterns of infiltration and how the spread of tumour impacts treatment options.

Supraglottic carcinoma: Approximately 30% of all laryngeal cancers arise in the supraglottic region. They often present in advanced stages, because symptoms (hoarseness, due to vocal cord involvement) do not occur until late. Five such cases were found in our study with associated transglottic invasion.

Epiglottic SCC: These are anterior midline cancers that primarily invade into the pre epiglottic space (PES). The primary sign of PES invasion at imaging noted was replacement of the normal fat by an abnormal enhancing soft tissue. The sensitivity and specificity of CT to detect invasion of the PES has been found to be 100% and 93% respectively.[21,22] One such case in our study invaded into the pre epiglottic space.

False cord SCC: These are lateral masses with a strong predilection for submucosal spread into the PGS. More extensive tumors were seen to destroy the thyroid cartilage and spread transglottically into the glottis and subglottis. Tumor spread to the paraglottic space (PGS) on CT is seen as replacement of the normal paraglottic fat by the enhancing tumor tissue. CT has a high sensitivity of about 95% to detect paraglottic tumor spread. The specificity, however, ranges between 50% and 75% as peritumoral inflammation may mimic tumor resulting in false positive assessments.[23]

Glottic SCCs: represent about 65% of all laryngeal cancers. Hoarseness of voice due to vocal cord involvement is the primary presenting symptom in these patients. Metastatic nodal disease is rare in glottic carcinomas due to the sparse lymphatic drainage of the glottis. Glottic SCCs commonly arise from the anterior half of the vocal cord and spread into the anterior commissure. Anterior commissural disease is seen on CT as soft tissue thickening of more than 1-2 mm. Six such cases were seen in our study with involvement of anterior commissure.

Subglottic SCC: These cancers are rare, accounting for only 5% of all laryngeal cancers, clinically silent and present late in the course of the disease and have a poor prognosis. Subglottic spread below the anterior commissure is seen as an irregular thickening of the cricothyroid membrane. No such case was found in our study.

While vocal cord mobility is best assessed at endoscopy, disease in the cricoarytenoid joint and interarytenoid region have been described as imaging correlates for vocal cord fixation.[24] One of the lesions showed involvement of the cricoarytenoid joint indicating vocal cord fixation,

which corroborated with findings of Keberle M et al.[25]
The CT criteria for reporting cartilage invasion include sclerosis, erosion, lysis and the presence of extralaryngeal tumor.[26,27] While sclerosis has a high sensitivity (83%) to detect intracartilaginous disease, it has a specificity that varies from one cartilage to another, being lowest in the thyroid cartilage (40%) and higher in the cricoid and arytenoid cartilages (76% and 79% respectively). Erosion or lysis and extralaryngeal tumor are highly specific criteria (86%-95%) for neoplastic cartilage disease; however, their sensitivity ranges between 64- 72% and 44%, respectively, as they occur very late in the course of the disease. By applying a combination of all the above criteria, the overall sensitivity of CT is as high as 91% with a negative predictive value of 95%.[26,27] Five of our cases showed cartilage involvement in the form of sclerosis of thyroid cartilage. These were similar to the findings of Mancuso et al.[24]

Thyroid gland: They comprise the majority of visceral space pathology. Radionuclide scanning remains the standard method for thyroid evaluation with small parts ultrasound providing supplementary anatomical information.
On CT, the normal thyroid gland is readily identified as a hyperdense triangular shaped area, lateral to the trachea. The inherent density is due to high iodine content. It shows intense enhancement following i.v. contrast administration. The density of abnormal thyroid tissue is generally lower than that of the normal gland.
Multiple thyroid nodules were diagnosed in this study with most of the cases showing homogeneous enhancement and no evidence of any bony /vascular / transspatial invasion. Around five of these lesions were thus diagnosed to be benign on the basis of the above imaging features. Multidetector row CT helped in diagnosing minimal retrosternal extension of thyroid in one case. Microcalcifications were seen in one case with carcinoma of thyroid**.** Coarse calcification was seen in both benign as well as the two malignant thyroid cases studied. CT was able to classify most lesions of thyroid and salivary gland origin as benign/malignant**.** However multi detector row CT was unable to give more differentiation in the form of the type of malignancy.
Thyroid nodules are detected incidentally at 9% of neck CT and MR imaging studies.[28] With increased use of CT, thyroid incidentalomas are becoming a growing problem. They are present in up to 1 in 6 CT studies of the neck.[29,30] Yoon DY, Chang SK, Choi CS, et al[31] reported that there was 9.4% (15/160) prevalence of malignancy among them. The further evaluation with ultrasound or biopsy should be performed, if an incidentaloma shows CT features suggesting malignancy (calcification; AP/T ratio>1.0; or mean attenuation value >130 HU).
In a patient presenting with adenopathy, the findings from a nodal mass that suggest a primary thyroid origin include cystic components, calcification,intense enhancement, or proteinaceous or hemorrhagic content appearing as hyperdensity on CT.[32] Nodal masses may be the first presentation for papillary carcinoma and medullary thyroid carcinoma and CT may be performed to search for an unknown primary.
CT is an additional ancillary tool to assess lesion extent, especially into mediastinum. It also shows possible invasion into surrounding structures and to evaluate for possible recurrent thyroid malignancy.In cases of anaplastic carcinoma of thyroid, CT accurately depicts the invasion of adjacent structures like the internal carotid artery, larynx, trachea and esophagus.[33,34]

Salivary gland tumors: On CT images, a parotid tumor located in the superficial lobe, with a round or oval contour and sharp margin, is more likely to be a benign tumor; otherwise, it might be a malignant tumor.[35] Pleomorphic adenomas may contain small calcifications. Imaging findings usually depend on tumour size. Irregularities in tumor margin and findings of extra glandular extension are the most helpful indicators by which benign and malignant parotid tumors may be differentiated.
A case of pleomorphic adenoma was seen involving left parotid gland which was well encapsulated and showed strong moderate enhancement**.** Three of the submandibular gland tumors and one parotid gland tumor showed heterogeneous enhancement with irregularity of tumor margins, a characteristic of malignant salivary gland lesions.
A case of parotid cyst was seen which showed minimally peripherally enhancing cyst density lesion in right parotid gland**.**

Neurogenic tumors: Tumors of the para pharyngeal space are rare, with neurogenic tumors being the most common. Neurilemmomas (also known as schwannomas or neuromas) account for 55% of these tumors. Most schwannomas of the vagus nerve are benign tumors. Schwannomas manifest between the third and sixth decades of the patient's life as a slow growing firm, painless mass in the lateral neck. They displace the carotid arteries anteriorly and medially, jugular vein laterally and posteriorly.
On CT images, vagal schwannomas were seen as well-defined masses of higher attenuation than muscle on contrast-enhanced images. They were found to separate the common or internal carotid artery from the jugular vein.[36] Splaying of ICA and ECA by a hypervascular mass (the Lyre sign) suggests the diagnosis of carotid body tumours.[36–38]
A branchial cleft cyst was described to be a typically well-circumscribed, homogeneously hypoattenuated mass, surrounded by a uniformly thin wall. The mural thickness was slightly increased likely due to infection. A branchial

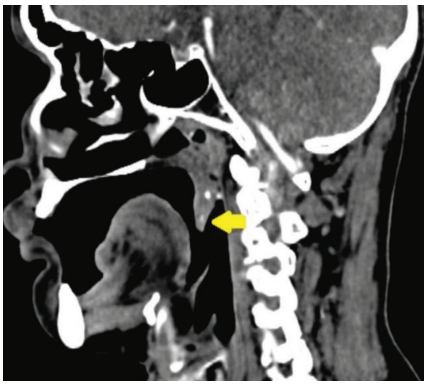

Figure-1: Hemangioma of uvula

Figure-2: Vallecular cyst

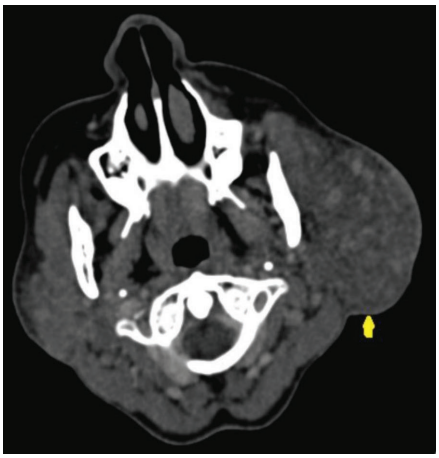

Figure-3: Kimura's disease

cleft cyst was seen in a young male which was located anterior to left sternocleidomastoid muscle, a type II cyst. In our study, a thyroglossal duct cyst was seen as a smooth, well-circumscribed lesion at the base of tongue, which is along the vertical course of the vestigial thyroglossal duct. The cyst had a thin wall and homogeneous fluid attenuation (10–18 HU). Elevated attenuation values of the fluid cyst reflect its increased protein content and generally correlate with a history of prior infections.

Among the benign lesions, multiple nodal masses were observed which were seen as peripherally enhancing enlarged lesions at various lymph node levels**.**

A unique case of hemangioma involving the uvula was observed (Fig.1). A bulky uvula with calcific foci and contrast enhancement was noted. Histopathology confirmed the diagnosis. Hemangiomas involving the oral cavity and especially, the uvula are extremely rare. After extensive research of available literature, this will be the first case to be reported with imaging findings.

A rare case of vallecular cyst was noted involving the left valleculae and left epiglottic fold (Fig.2). Incidence of vallecular cyst varies from 1/250 to 1/4200 people or 10% of population on laryngoscopy. They are seen as well-defined cystic lesions along the lingual surface of epiglottis displacing the epiglottis inferomedially and causing symptoms like inspiratory stridor and respiratory distress in infants.

Kimura's disease is a rare chronic immune mediated disorder which is seen in Asian populations. A case of Kimura's disease was studied in which there were well-defined iso- to hyper-attenuated nodular masses in the subcutaneous tissue in vicinity of an enlarged parotid gland with lymphadenopathy (Fig.3).

Limitations of the study- Most of the cases in this study were conclusive on imaging and were not biopsied. Therefore, no statistical correlation was done between the imaging and biopsy results.

CONCLUSION

The enhancement patterns and extent of bony involvement were more helpful in differentiating between benign and malignant neck lesions, as compared to the rest of the defining criteria. Such an evaluation of neck masses on multidetector CT was able to guide the further management plan of each patient effectively and solidifies the role of multidetector CT in neck mass evaluation.

REFERENCES

1. Federici S, Silva C, Marechal C, Laporte E, Sevely A, Grouteau E, et al. Retro- and parapharyngeal infections: standardization of their management]. Arch Pediatr. 2009;16(9):1225–32.
2. Ozkiris M, Kala M. Histopathological examination of patients operated on for a neck mass: 4-year follow-up results. Turk Patoloji Derg. 2011;27(2):134–7.
3. Bhattacharjee A, Chakraborty A, Purkaystha P. Prevalence of head and neck cancers in the north east-An institutional study. Indian J Otolaryngol Head Neck Surg. 2006;58(1):15–9.
4. Misra S, Chaturvedi A, Misra NC. Management of gingivobuccal complex cancer. Ann R Coll Surg Engl. 2008;90(7):546–53.
5. Brown JS, Griffith JF, Phelps PD, Browne RM. A comparison of different imaging modalities and direct inspection after periosteal stripping in predicting the invasion of the mandible by oral squamous cell carcinoma. Br J Oral Maxillofac Surg. 1994;32(6):347–

59.
6. van den Brekel MW, Castelijns JA, Stel H V, Golding RP, Meyer CJ, Snow GB. Modern imaging techniques and ultrasound-guided aspiration cytology for the assessment of neck node metastases: a prospective comparative study. Eur Arch Otorhinolaryngol. 1993;250(1):11–7.
7. Iyer SG, Pradhan SA, Pai PS, Patil S. Surgical treatment outcomes of localized squamous carcinoma of buccal mucosa. Head Neck. 2004;26(10):897–902.
8. Pradhan SA, Rajpal MR. Marginal mandibulectomy in the management of squamous cancer of the oral cavity. Indian J Cancer. 1987;24(3):167–71.
9. Majoufre C, Faucher A, Laroche C, De Bonfils C, Siberchicot F, Renaud-Salis JL, et al. Supraomohyoid neck dissection in cancer of the oral cavity. Am J Surg. 1999;178(1):73–7.
10. Kolli VR, Datta R V, Orner JB, Hicks WLJ, Loree TR. The role of supraomohyoid neck dissection in patients with positive nodes. Arch Otolaryngol Head Neck Surg. 2000;126(3):413–6.
11. Ferlito A, Rinaldo A, Silver CE, Gourin CG, Shah JP, Clayman GL, et al. Elective and therapeutic selective neck dissection. Oral Oncol. 2006;42(1):14–25.
12. Kowalski LP, Bagietto R, Lara JR, Santos RL, Tagawa EK, Santos IR. Factors influencing contralateral lymph node metastasis from oral carcinoma. Head Neck. 1999;21(2):104–10.
13. Jalisi S. Management of the clinically negative neck in early squamous cell carcinoma of the oral cavity. Otolaryngol Clin North Am. 2005;38(1):37–46, viii.
14. Manikantan K, Khode S, Dwivedi RC, Palav R, Nutting CM, Rhys-Evans P, et al. Making sense of post-treatment surveillance in head and neck cancer: when and what of follow-up. Cancer Treat Rev. 2009;35(8):744–53.
15. de Bree R, van der Putten L, Brouwer J, Castelijns JA, Hoekstra OS, Leemans CR. Detection of locoregional recurrent head and neck cancer after (chemo) radiotherapy using modern imaging. Oral Oncol. 2009;45(4–5):386–93.
16. Lell M, Baum U, Greess H, Nomayr A, Nkenke E, Koester M, et al. Head and neck tumors: imaging recurrent tumor and post-therapeutic changes with CT and MRI. Eur J Radiol. 2000;33(3):239–47.
17. Hermans R. Posttreatment imaging in head and neck cancer. Eur J Radiol. 2008;66(3):501–11.
18. Offiah C, Hall E. Post-treatment imaging appearances in head and neck cancer patients. Clin Radiol. 2011;66(1):13–24.
19. Hudgins PA. Flap reconstruction in the head and neck: expected appearance, complications, and recurrent disease. Eur J Radiol. 2002;44(2):130–8.
20. Chong VFH. Post treatment imaging in head and neck tumours. Cancer Imaging. 2005;5:8–10.
21. Zbaren P, Christe A, Caversaccio MD, Stauffer E, Thoeny HC. Pretherapeutic staging of recurrent laryngeal carcinoma: clinical findings and imaging studies compared with histopathology. Otolaryngol Head Neck Surg. 2007;137(3):487–91.
22. Loevner LA, Yousem DM, Montone KT, Weber R, Chalian AA, Weinstein GS. Can radiologists accurately predict preepiglottic space invasion with MR imaging? AJR Am J Roentgenol. 1997;169(6):1681–7.
23. Becker M, Burkhardt K, Dulguerov P, Allal A. Imaging of the larynx and hypopharynx. Eur J Radiol. 2008;66(3):460–79.
24. Mancuso AA, Tamakawa Y, Hanafee WN. CT of the fixed vocal cord. AJR Am J Roentgenol. 1980;135(3):7529–34.
25. Keberle M, Hoppe F, Dotzel S, Hahn D. Tumor volume as determined by computed tomography predicts local control in hypopharyngeal squamous cell carcinoma treated with primary surgery. Eur Radiol. 2004;14(2):286–91.
26. Becker M, Zbaren P, Casselman JW, Kohler R, Dulguerov P, Becker CD. Neoplastic invasion of laryngeal cartilage: reassessment of criteria for diagnosis at MR imaging. Radiology. 2008;249(2):551–9.
27. Beitler JJ, Muller S, Grist WJ, Corey A, Klein AM, Johns MM, et al. Prognostic accuracy of computed tomography findings for patients with laryngeal cancer undergoing laryngectomy. J Clin Oncol. 2010;28(14):2318–22.
28. Langer JE, Baloch ZW, McGrath C, Loevner LA, Mandel SJ. Thyroid nodule fine-needle aspiration. Semin Ultrasound CT MR. 2012;33(2):158–65.
29. Nguyen X V, Choudhury KR, Eastwood JD, Lyman GH, Esclamado RM, Werner JD, et al. Incidental thyroid nodules on CT: evaluation of 2 risk-categorization methods for work-up of nodules. AJNR Am J Neuroradiol. 2013;34(9):1812–7.
30. Hoang JK, Raduazo P, Yousem DM, Eastwood JD. What to do with incidental thyroid nodules on imaging? An approach for the radiologist. Semin Ultrasound CT MR. 2012;33(2):150–7.
31. Kim HC, Yoon DY, Seo YL, Namkung S, Hong MS, Baek S, et al. Incidental thyroid lesions identified by ultrasound in patients with non-thyroidal head and neck cancer. Acta Radiol. 2013;54(10):1153–8.
32. Hoang JK, Vanka J, Ludwig BJ, Glastonbury CM. Evaluation of cervical lymph nodes in head and neck cancer with CT and MRI: tips, traps, and a systematic approach. AJR Am J Roentgenol. 2013;200(1):W17-25.
33. Takashima S, Morimoto S, Ikezoe J, Takai S, Kobayashi T, Koyama H, et al. CT evaluation of anaplastic thyroid carcinoma. AJR Am J Roentgenol. 1990;154(5):1079–85.
34. Venkatesh YS, Ordonez NG, Schultz PN, Hickey RC, Goepfert H, Samaan NA. Anaplastic carcinoma of the thyroid. A clinicopathologic study of 121 cases. Cancer. 1990;66(2):321–30.
35. Lu Y-C, Fan W-J, Shen J-X, Xiao P. CT features of parotid tumors: an analysis of 133 cases. Ai Zheng. 2007;26(11):1263–7.
36. Furukawa M, Furukawa MK, Katoh K, Tsukuda M. Differentiation between schwannoma of the vagus nerve and schwannoma of the cervical sympathetic chain by imaging diagnosis. Laryngoscope. 1996;106(12 Pt 1):1548–52.
37. Liu R, Fagan P. Facial nerve schwannoma: surgical excision versus conservative management. Ann Otol Rhinol Laryngol. 2001;110(11):1025–9.
38. Lustrin ES, Palestro C, Vaheesan K. Radiographic evaluation and assessment of paragangliomas. Otolaryngol Clin North Am. 2001;34(5):881–906.

Source of Support: Nil; **Conflict of Interest:** None

Submitted: 23-09-2017; **Published online**: 30-10-2017