www.jmscr.igmpublication.org
Impact Factor 5.84
Index Copernicus Value: 83.27
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v5i7.216

IGM Publication
Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Role of computed tomography in the evaluation of neck masses

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Abstract

Introduction: *Neck masses can be of diverse etiology and origin and usually pose a diagnostic challenge to treating surgeon or physician. A patient with neck mass almost always is referred for imaging; a very close and compact arrangement of vital structures, coupled with complex deposition of deep cervical fascia (DCF) makes neck imaging difficult even for general radiologist. Ultrasound (US), computed tomography (CT) and magnetic resonance imaging (MRI) can all be used in non invasive assessment of neck lesions. While ultrasound can provide important information about superficial lesions like those affecting the thyroid and neck vessels, it has got limited spatial resolution moreover it is operator dependant. It is also poor is characterizing lesion of deep spaces of neck. MRI is extremely useful in assessment of neck lesions due to its excellent soft tissue delineation and multiplaner imaging capabilities but is limited by its availability and cost. Moreover it requires patient to remain still for a longer duration which sometimes is not possible in painful neck masses and may require sedation in paediatric patients. Because of these drawbacks associated with ultrasound and MRI, CT has emerged as an important modality for diagnosis of neck lesions. Various neck masses which can reliably be diagnosed on computed tomography include congenital and developmental masses, infections, neoplastic diseases and vascular masses. This study was conducted to study the utility of computed tomography in above mentioned neck masses.*

Aims and Objectives: *To study the use of spiral Computed tomography and multidimensional reformations for detection and characterization of various neck masses i.e. congenital and developmental neck masses, infections, neoplastic and vascular masses.*

Materials and Methods: *This was a prospective cohort study consisting of 117 patients who presented with neck masses conducted at a tertiary care medical hospital in an urban area. The patients having history suggestive of neck mass like hoarseness of voice, palpable lesion in neck, mass seen on indirect laryngoscopy and neck survey revealing neck mass of unknown etiology were included in this study. The patients were kept NBM at least for 4 hours before doing CT scan. CT neck with contrast was done according to a pre-defined protocol. Multiplaner reconstructions were performed whenever applicable. The images were reviewed and studied with special consideration to the purpose of the study.*

Results: *Total 117 patients with neck masses who met the criteria of the study were included in this study. There were 69 males (58.97%) and 48 females (41.03%) with a male to female ratio of 1:0.69. Most common etiology of neck mass was found to be infections (17.9%) followed by ca larynx (14.5%) and swellings involving thyroid gland (11.1%). Least common causes were found to be schwannoma, laryngeal papillomatosis, tracheal tumours, brachial cysts, lipoma of neck and pleomorphic adenoma of submandibular gland which were seen in 0.85% each. The study of infectious lesions revealed that the most common space involved in infections was submandibular space which were seen in 12/21 (57.14%) patients followed by retropharyngeal (23.81%) and pre vertebral spaces (9.52%). Carcinoma larynx and hypopharynx was found to be most common in the age group of 61-70 years (12/17) and was more common in males. It*

was not seen in patients below 30 years or above 70 years of age in our study. While the most common site of laryngeal carcinoma was found to be supraglottic region (14/17) followed by glottic (2/17) and transglottic regions (1/17), hypopharyngeal carcinoma was most commonly seen in the region of pyriform fossa (9/12). Neoplastic lesions of neck were found to be associated with lymphadenopathy involving level I -IV. The most common pathology seen in swellings involving thyroid gland was multi nodular goiter (9/13) followed by anaplastic carcinoma (3/13) and papillary carcinoma (1/13). Most common pathology involving parotid was chronic pancreatitis which was seen in 2 patients. Other causes of neck swellings found in our study included neoplastic diseases (ca-buccal mucosa, tonsil, cervical esophagus and nasopharynx), ranula, parathyroid diseases, lymohangioma, haemangioma and lymphadenopathy.

Conclusion: *Though in recent years MR imaging is considered to be imaging modality of choice for neck masses computed tomography is extremely useful in defining bony involvement and soft tissue extent of the lesion. It is fast, widely available and suitable for even patients in whom MRI may be contraindicated.*

Keywords: *Neck swellings, Computed Tomography, Staging of tumour, Lymphadenopathy.*

Introduction

Neck is a compact and vital portion of the human body. The contents of neck vary from blood vessels (carotid artery, jugular veins), Glands (Thyroid, parathyroid), muscles (Diagastric, Sternocleidomastoid, Trapezius etc) and lymph nodes. Lump in the neck is a very common presenting complaint in routine practice [1]. This lump may be varied in etio-pathogenesis and prognosis. The prognosis not only depends upon the site of origin of lump (Gland, muscle or vessels) but also type of pathology (inflammatory or neoplastic) and in malignant diseases stage of the disease and involvement of lymph nodes [2]. Varied etiopathogenesis and prognosis makes it imperative that any neck swelling be diagnosed accurately and in time. The role of imaging in this endeavor can never be over-emphasized [3]. Neck Imaging has always been a challenge to the general radiologists. A very close and compact arrangement of vital structures, coupled with complex deposition of deep cervical fascia (DCF) makes neck imaging difficult [4].

Before advent of cross sectional imaging radiologists were of limited help in the diagnosis of neck lesions especially those involving the deep spaces of suprahyoid neck (SHN). The traditional concept of neck anatomy described as various triangles is of little help in cross sectional imaging which relies solely on spatial concept of neck anatomy described in terms of various neck spaces [5]. It was the pioneering work of Smoker WR, Harnsberger and others who delineated the spatial anatomy of neck and did extensive studies on radiological and pathological correlation of neck lesions[6]. Ultrasound (US), computed tomography (CT) and magnetic resonance imaging (MRI) can all be used in non invasive assessment of neck lesions. While ultrasound can provide important information about superficial lesions like those affecting the thyroid and neck vessels, it has got limited spatial resolution and is subjected to inter-observer variations[7]. It is also poor is characterizing lesion of deep spaces of neck. MRI is extremely useful in assessment of neck lesions due to its excellent soft tissue delineation and multiplaner imaging capabilities but is limited by its unsuitability in claustrophobic patients, and individuals with certain devices like pacemakers and cochlear implants. Moreover its availability is not uniform and cost is also prohibitive [8,9,10].

Anatomically, the neck is divided into two main portions viz. the suprahyoid neck (SHN) and infrahyoid neck (IHN). Each of these is further divided into various neck spaces by cervical fascia. These spaces can be affected by various pathological conditions ranging from congenital anomalies infection, inflammations, neoplasms and traumatic conditions [11]. The deep cervical fascia governs the spread of these diseases across these spaces. CT effectively demonstrates these spaces and helps characterization of the pathological process. It also helps in assessment of spread of pathology to contiguous spaces and also provides information about regional lymph nodes and vascular anatomy. CT is an invaluable tool in the staging of head and neck cancers and pre-operative assessment of respectability [12]. The introduction of spiral CT was an important milestone in the history of neck

imaging. Spiral CT rapidly gained acceptance for neck imaging and today it is considered to be the "'gold standard" for neck imaging [13].

Spiral or helical CT refers to volume acquisition CT which involves simultaneous translation of patient at constant rate through the gantry during continuous rotation of source detector assembly. As a result, the X-ray tube focus describes a spiral or helical path around patient resulting in spiral projection data set which can be obtained in single breath hold [14]. Spiral CT is a very useful tool for neck imaging because it takes significantly less time for scanning thereby reducing motion and respiratory mis-registration artifacts. Moreover because of fast scanning the need for sedation is also reduced. High quality three dimensional (3-D) and multiplaner images, Improved contrast enhancement of head and neck tumors, improved vascular opacification and reduced amount of required contrast are some of the major advantages of spiral CT used in neck imaging [15].

Aims and Objectives

To study the use of spiral Computed tomography and multidimensional reformations for detection and characterization of various neck masses i.e. congenital and developmental neck masses, infections, neoplastic and vascular masses.

Materials and Methods

The study was approved by institutional ethical committee. It was a prospective cohort study consisting of 117 patients who presented with neck masses. It was conducted at a tertiary care medical hospital in an urban area. The patients having history suggestive of neck mass like hoarseness of voice, palpable lesion in neck, mass seen on indirect laryngoscopy and neck survey revealing neck mass of unknown etiology were included in this study. All these patients were studied by spiral multislice multidetector Computed tomography (Siemen's Somatodom Volume Zoom machine).

Patients were selected on the basis of:

- Clinical history or examination suggestive of neck mass like hoarseness of voice, mass lesion suspected on indirect laryngoscopy, Palpable neck mass, Pain, fever, or tenderness.
- Neck survey in patients with neck mass of unknown etiology.

All patients were called with at least 4 hour of fasting before the scan. An informed consent was obtained from each patient. The patient was placed on gantry table in supine position with both arms resting by side and shoulder pushed down, undue extension of neck was avoided. A digital lateral scanogram was obtained. Non enhanced 5x5 mm sections were obtained from base of skull to thoracic inlet (extended downwards when required). Contrast scans were obtained by injecting Inj. Urovideo 76% 50ml i.v. by pressure injector after delay of 25 seconds Coronal reconstructions done in case of mass lesions to know craniocaudal extension.

All images were stored in the memory and were reviewed on console and on hard copy. Multiplaner reconstructions were performed whenever applicable. An anesthetist was kept standby to sedate children patients. All patients were monitored for a period of half an hour after the scan in the CT scan department before being sent back.

The data was analyzed with an emphasis to know the demographic characteristics of the patients, presenting complaints, origin, extension and anatomical extension of the swelling and presence of lymphadenopathy.

Results

The study was a a prospective cohort study comprising of 117 patients. Out of the studied cases there were 69 (58.97%) males and 48 (41.03%) were females with a M:F ratio of 1:0.69.

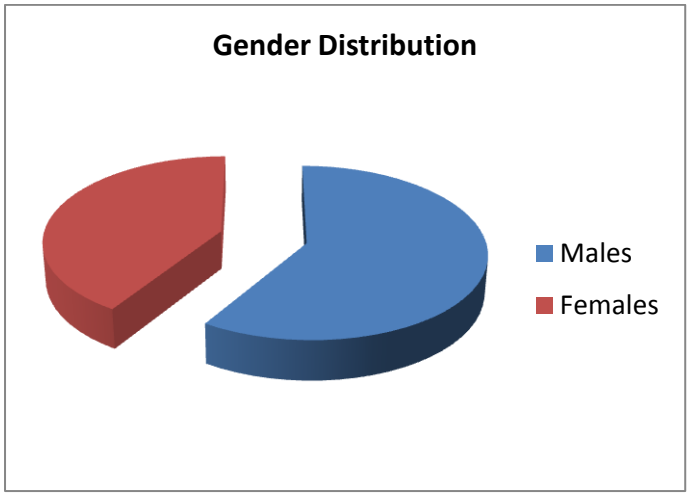

Figure 1: Gender Distribution of the studied Cases.

Patients most commonly comprise of age group of 61-70 years (18.8%) followed by 31-40 (17.09%) and 41-50 (17.09%) years. The least common age group was found to be the age group of 71-80 years (1.71%).

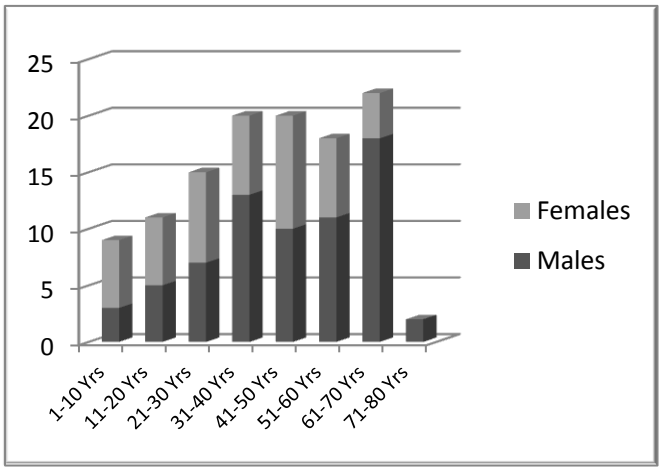

Figure 2: Age and gender distribution of the studied case.

The analysis of the Etiopathogenesis of the studied cases revealed that the most common cause of neck swelling was infections (17.9%) followed by carcinoma larynx (14.5%), carcinoma hypopharynx (1.2%) and thyroid gland diseases (11.1%). Less common pathologies included haemangioma, lipoma, schwannoma, and brachial cyst (0.85% each). We diagnosed 7 cases of nasopharyngeal carcinoma. It appeared as enhancing hypodense mass in the region of Fossa of Rosenmullar, obliterating the fossa and causing varying degree of bone destruction metastatic lymphadenopathy. 8 cases were of oropharyngeal cancers arising from posterior and lateral wall of pharyngeal mucosal space extending from inferior margin of nasopharynx to pharyngoepiglottic fold.

Table 1 Various etiologies of swelling in the neck

Lesion	No. of patient	Percentage
Infections	21	17.9%
Ca larynx	17	14.5%
Ca hypo pharynx	12	10.2%
Thyroid gland disease	13	11.1%
Lymphadenopathy	10	8.5%
Parotid gland disease	8	6.8%
Nasopharyngeal Ca	7	5.9%
Ca Oropharynx	8	6.8%
Ca buccal mucosa	2	1.7%
Ranula	3	2.5%
Ca Tonsil	2	1.70%
Parathyroid disease	2	1.70%
Ca cervical oesophagus	2	1.70%
Lymphangioma	2	1.70%
Schwannoma of Neck	1	0.85%
Laryngeal Papillomatosis	1	0.85%
Tracheal tumor	1	0.85%
Brachial cyst	1	0.85%
Lipoma of neck	1	0.85%
Laryngeal Schwannoma	1	0.85%
Pleomorphic adenoma of submandibular gland	1	0.85%
Hemangioma of face	1	0.85%

The study of site of infection revealed that the most common space to be involved in infections was submandibular space (12/21 patients) followed by retropharyngeal space (5/21 patients), prevertebral space (2/21), pharyngeal mucosal space (1%) and multiple spaces (1/21).

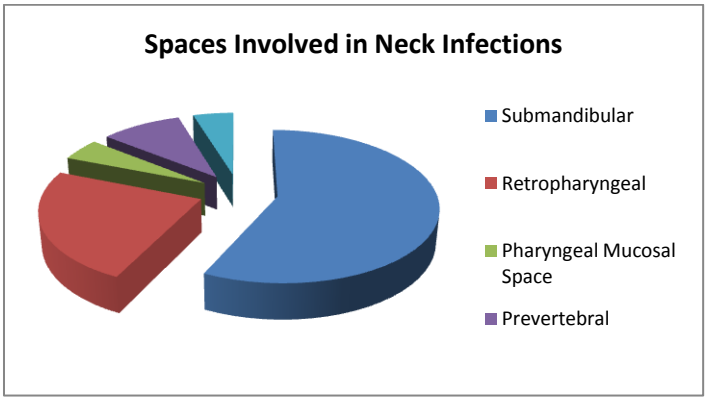

Figure 3: Neck spaces involved in infections.

In males the carcinoma of larynx and hypopharynx was most common in between the age of 61-70 years (11/26) while in females the most common age group involved was 31-40 years (2/3). Overall it was found to be most

common in 7th decade and males were more commonly affected than females.

Table 2: Gender and age distribution of carcinoma larynx and hypopharynx

Age group	Male	Female
1-10	0	0
11-20	0	0
21-30	0	0
31-40	1	2
41-50	7	0
51-60	7	0
61-70	11	1
71-80	0	0
81-90	0	0

Laryngeal carcinoma was most commonly seen in supraglottic region (14/17) followed by glottis (2/17) and transglottic (1/17) regions. There was no patient in whom carcinoma larynx involved subglottic region.

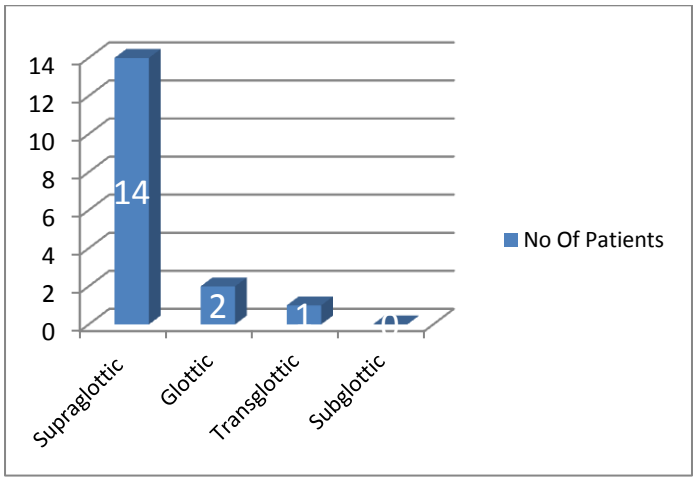

Figure 4: Laryngeal carcinoma involving various sites

Hypopharyngeal carcinoma was most commonly found to be involving pyriform fossa (9/12) followed by posterior hypopharyngeal wall (2/12) and post-crioid region (1/12).

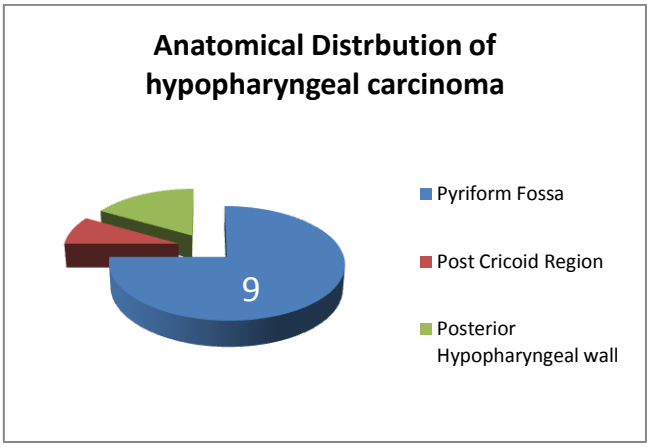

Figure 5: Anatomical Distribution of hypopharyngeal carcinoma.

Lymph node involvement (I-IV) was seen most commonly in supraglottic carcinoma and carcinoma involving pyriform fossa. While glottic carcinoma was not found to be associated with lymphadenopathy

Table 3: Cases of carcinoma larynx and hypopharynx presenting with lymphadenopathy

Primary site	No. of patient	Lymph node level
Larynx		
Supraglottic	11	I, II, III, IV
Transglottic	-	-
Hypo pharynx		
Pyriform fossa	5	I,II,III
Posterior hypo pharyngeal wall	2	II, III
Oropharynx	3	I, II

Thyroid gland was found to be involved in many cases of swellings in neck. The most common pathology involving thyroid gland was found to be multinodular goiter (9/13) followed by anaplastic carcinoma (3/12) and papillary carcinoma of thyroid (1/12).

Table 4: Thyroid Gland Diseases in studied cases

Pathology	No. of cases	Imaging appearance	Lymhadeno pathy	Retro-sternal extension
Multinodular goiter	**9**	**Heterogeneously enhancing mass with calcification**	**-**	**3 cases**
Anaplastic carcinoma	**3**	**Hypodense mass with heterogeneous enhancement**	**-**	**-**
Papillary carcinoma	**1**	**Hyper vascular mass**	**+**	**-**

The most common parotid gland pathology in studied cases was found to be chronic parotitis (2/8) followed by haemangioma, teratoma, malignant transformation in pleomorphic adenoma, lymphoepithelial cyst and mucoepidermoid carcinoma (1 patient each).

Table 5: Parotid Gland Diseases in studied cases

Pathology	No. of patient	CT appearance
Hemangioma in left parotid gland	1	Enhancing soft tissue density lesion with a phlebolith
Teratoma in left parotid gland	1	Septated fat containing lesion with mural nodule
Malignant transformation in pleomorphic adenoma	1	Heterogeneously enhancing mass with well defined borders.
Lymphoepithelial cysts	1	Multiple cystic lesion in B/L parotid gland
Chronic parotitis	2	Diffuse enlargement and minimal enhancement
Pleomorphic adenoma	1	Well defined enhancing lesion
Mucoepidermoid carcinoma	1	Heterogeneously enhancing lesion with central non-enhancing region.

Discussion

In last few years MR imaging has become the imaging modality of choice for neck masses due to better soft tissue and contrast resolution. Moreover MRI is a non-ionizing imaging modality. Computed tomography, though involves ionizing radiation, have advantage of being easily available and quick. It can also be used in patients with devices like cochlear implants and pacemakers in whom MRI is contraindicated. Moreover CT is precise in bone assessment [16].

In this study total 117 patients referred for neck lesions were studied using spiral multislice multidetector CT. 69 patients were male and 48 were female.We used 50 ml of 76% Inj. urovideo (sodium and meglumine diatriazoate) an ionic water soluble contrast medium, and were able to obtain good and consistent opacification of neck vessels and enhancement of lesions. The contrast agent used was non ionic contrast Omnipaque (Iohexol) in 3 patients two patients were asthmatic and 3rd was having allergies to sulfonamide group of antibiotics. Decreasing the contrast load and optimizing the contrast enhancement by using delay time of 25 sec gave us satisfactory imaging quality.

In our study, 15 patients developed minor reactions to contrast like nausea, flushing of face, itching etc. which was treated by injection ranitidine and hydrocortisone. None of our patients experienced a major reaction and there was no morbidity or mortality from contrast reaction. The use of much lesser volume of contrast agent was proved to be a better strategy in our study.

We administered contrast medium through a power injector at a rate of 2.5 m/sec. The method of contrast administration and use of ionic contrast correlated with the recommendation of Hopper KD [17]. The use of lesser volume of contrast was justified as discussed by Yoon DY et al [18]. Who demonstrated that 0.75ml/kg of non- ionic contrast gives good vascular opacification of neck vessels. In suspected mass lesion, reformatted sagittal and coronal images were obtained. We found reformatted images to be extremely useful especially for knowing the cranio-caudal extent of the lesions. Our findings correlated with those of Mukherji et al, Silverman PM et al and Keberle et al [19,20,21].

In our study the most common cause of neck mass was found to be infections. We diagnosed 21 cases of neck infections affecting various neck spaces. In 12 patients (57%) there was affection of submandibular space. Out of 12 patients, 5 patients were having Ludwig's angina and 7 were having submandibular abscess. In two patients there was air inside the abscess. In all 7 patients submandibular abscess were associated with submandibular lymphadenopathy and 3 cases of Ludwig's angina. There were 5 cases of retropharyngeal abscesses (23.80%). In one patient there was erosion of C4, 5 vertebral bodies and extensive cervical lymphadenopathy.

In 2 patients there was prevertebral abscess. (9.52%). In one patient there was destruction of C5 to D1 vertebral bodies, suprascapular abscess and also cold abscess along rib. The other patients were having only prevertebral abscess extending into retropharyngeal space.

In our study 17 patients were diagnosed as having laryngeal cancers (14.5%). Laryngeal cancers are seen more commonly in males. This was comparable with the findings of Sasaki CT who found laryngeal carcinoma to be about 5 time more common in males. The higher incidence of laryngeal cancers was attributed to a greater incidence of tobacco and alcohol consumption. In this study the peak age was in 7th decade. In our study 14 patients (82%) were diagnosed to have supraglottic cancer. All the patients had extensive disease at presentation and 11 of these (64%) presented with metastatic cervical lymphadeno-pathy. Other causes of neck swelling were found to be carcinoma hypo-pharynx, Thyroid gland disease and lymphadenopathy. The findings were similar to those found by shugar et al [22].

12 patients with clinically detected thyroid swelling and one with submandibular lymphadenopathy were referred for CT scanning. Of 12 patients, 9 patients were suspected to have multinodular goiter and other 3 were suspected to have malignancies of thyroid with metastatic neck adenopathy. Although, CT is not the primary modality for imaging of thyroid gland pathologies it has an ancillary role in evaluation of retrosternal extension in benign and enlarged nodes in evaluation of metastatic adenopathy. These imaging indications are in accordance with findings of Hopkin CR et al [23].

The common pathologies involving parotid glands were chronic pancreatitis, haemangioma, teratoma and pleomorphic adenoma. One patient who was a known case of mucoepidermoid carcinoma of parotid gland referred for CT scan. The tumor had ill-defined borders with heterogeneous enhancement and central non enhancing region, lesion causing mass effect on parapharyngeal space and compressing the internal jugular rein. The imaging appearance correlated with the study of Byrne MN et al [24] and Camacho AE et al [25].

Conclusion

CT neck is fast, well tolerated, widely available and precise method for localization and characterization of the neck swellings. It not only precisely localize the lesion but also help in knowing the extent of the mass, allows differentiation of solid, cystic and mixed consistency of masses, tumor staging, and pre-surgical assessment. It has an advantage over MRI when the patients can't remain still, claustrophobic individuals or when patients have MRI incompatible implanted devices like cochlear implants or cardiac pacemakers.

Conflict of interest: None

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