Multidetector-CT Profile of Benign and Malignant Neck Masses among Patients of Guwahati, Assam

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ABSTRACT

BACKGROUND

Multidetector computed tomography (MDCT) is the imaging of choice and the most commonly used investigation in head and neck lesions, because of its fast and readily available nature. Our study focused on contrast enhanced multidetector CT profile of neck masses in determining their nature among different demographic profile. It provides volumetric helical data, optimal multiplanar and 3D reconstructions.

METHODS

This is a retrospective observational study carried out in the Department of Radiology, Gauhati Medical College and Hospital, Guwahati, among 60 cases of clinically diagnosed neck masses, from December 2011 to June 2013. All patients were selected from out-patient departments (OPD) and indoor wards of various departments (mostly from ENT department). Few cases were also taken from Dr. B. Baruah Cancer Institute. Patients from both sexes and all ages were included as part of the study. Chi square test/Fischer exact test have been used to find the significance of association of CT scan findings with the final diagnosis. Diagnostic statistics such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy have been used to find the correlation of CT scan with the final diagnosis.

RESULTS

Thin slice scanning with thinner reconstructions, maximum intensity production (MIP), shaded surface display (SSD), multiplanar reformation (MPR) and curved reformatted images are the advantages of MDCT. CT has 100 % accuracy in bony involvement detection and 96 % accuracy in neck lesion diagnosis. Therefore, CT can accurately localise and characterise the neck lesions.

CONCLUSIONS

The neck lesion location and its characteristics determination has significantly improved because of computed tomography. Bone erosions and expansion are accurately determined by a CT scan. CT scan can accurately delineate the disease that provides a definite pre-operative diagnosis, planning radiotherapy ports and post therapy follow up.

KEYWORDS

Bone Invasion, Lymph Nodes, Neck Space Extensions, Multidetector-CT

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BACKGROUND

Radiological evaluation of neck masses has changed dramatically since the advent of ultrasound (US), multidetector computed tomography (MDCT) and magnetic resonance imaging (MRI). The use of these newer modalities permits precise anatomic localisation, extent of the masses and allows for differentiation of solid, cystic and mixed masses. Imaging techniques that utilise ionising radiation carry with them a potential lifetime increased risk of developing malignancy and this should be kept in mind when selecting the imaging techniques to use. Multidetector CT is easily available in most of the hospitals and is presently the imaging choice most commonly used in head and neck lesions. Although MRI images the bone marrow effectively, unlike MDCT it cannot examine bony cortex. CT has superior spatial resolution and is generally a faster technique which may be very important in a patient with compromised airway.

The development of modern cross-sectional imaging methods have significantly altered the treatment and management of diseases of upper aero-digestive tract. Important decisions that were once made On-table during the surgeries are now being made well before the surgeries by the use of MDCT and MRI. Detailed information with respect to treatment options and the extent of lesions is determined by cross-sectional imaging that may be missed by physical examination alone.[1] Imaging helps to determine the tumour and its adjacent tissue resectability criteria to get a tumour negative margin. Pre surgical cross-sectional imaging is accepted as an important adjunct to physical examination because it improves the accuracy of staging in patients with malignancies of upper aero-digestive tract.[2]

Post-surgical and post radiation imaging are now vastly regarded as mainstay of patient follow-up. Imaging surveillance prolongs disease free survival and improves palliation. Early treatment of local recurrence, can result in good palliation, often lasting several years, which is of precious value to these patients and their families. Owing to the complex anatomy of the neck, a precise knowledge of loco-regional anatomy and recognition of the disease patterns are vital for a meaningful differential diagnosis. Thorough anatomical correlation is mandatory to get an early recognition of neck lesions.

Present studies with high-resolution helical/multi detector computed tomography and multiplanar reconstruction permits a detailed analysis of the loco-regional neck anatomy and crucial in understanding many of its disorders including mass lesions. With this, we can determine the things involved in conservative neck surgeries, nodal architecture, functional assessment, post treatment neck changes, relevant surgical anatomy of the neck spaces and to relate better with our ENT colleagues.[3] So, considering all these backgrounds, a humble attempt was taken for the present study "Multidetector-CT profile of benign and malignant neck masses among Guwahati, Assam population" in the Department of Radiology, Gauhati Medical College and Hospital, Guwahati, the premier medical institution in the North East Region.[3]

Objectives

To describe the contrast enhanced helical MDCT profile of neck masses with regard to:

1. Lesion characterisation based on site, morphology and enhancement.
2. Lesion extension to the adjacent structures, vessels, bones involvement and lymph nodes.
3. Surgical and pathological correlation, wherever applicable.

METHODS

This retrospective study was carried out among 60 cases of clinically diagnosed neck masses, in the Department of Radiology, Gauhati Medical College and Hospital, Guwahati from December 2011 to June 2013. All the patients were selected from out-patient departments and indoor wards of various departments (mostly from ENT department). Patients from both sexes and all ages were included in the study. Findings are correlated with final surgical/pathological diagnosis wherever applicable.

Inclusion Criteria

- Patients presenting with palpable neck masses
- Neck lesions detected on ultrasound.
- Patients presenting with symptoms related to neck area.

Exclusion Criteria

Patients with history of trauma.

60 patients with neck lesions were subjected for CT examination. Then a classification scheme for categorising neck lesions on the basis of the site of origin of the lesion and characterisation of contrast administration was worked out.

CT Imaging Protocol

For CT imaging, patients were scanned in the supine position on the scanner gantry with mild hyperextension of the neck so that hard palate is roughly parallel to the X-ray beam. Usually, the patient was scanned in normal breathing with suspension of swallowing. In special circumstances, the scans were done with Valsalva manoeuvre and 'E' phonation. Contiguous 5 mm thick axial images were obtained from the level of base of skull to lung apices.

Preparation of Patient

After taking proper history, clinical examination and laboratory investigations, the patient was prepared for CT scanning. Before performing the scan, the procedure and objective of performing the scan was explained to the patient and the attendant. Formal consent was taken before IV contrast examination from the patient/attendant. The patient was advised not to take anything by mouth 4 - 6 hours prior to performing the scan.

Equipment
Philips MX 16 CT Scanner

CT Protocol
Patient positioning: Spine, arms by the side of the body, shoulder was depressed.
Region: Base of the skull to lung apices.
Scanogram: Lateral, length depending upon the patient.
Plane of imaging: Parallel to the intervertebral discs of cervical spine or parallel to the laryngeal ventricle in suspected laryngeal mass lesion.
IV contrast: Non-ionic iodinated contrast, depending on body weight.
Injection rate: Rapid IV bolus by hand injection
Mode: Spiral sequence.
Slice: 5 mm, thinner sections (3mm) occasionally through area of interest.
Feed/Rotation: 7 mm.
Reconstruction: 4 mm
Scan orientation: Cranio-caudal.
KV: 130 mA: 83-105.
FOV: Depending on size of patient.
Window settings: Soft tissue (Width / Centre – 350 / 50); Bone (Width / Centre – 1500 / 450)

Post Processing
Multiplanar reformatting (both coronal and sagittal planes) were done whenever necessary. All images were reconstructed with bone algorithm to detect bone and cartilage invasion.

Statistical Analysis
Our study constitutes descriptive statistical analysis. Continuous measurement results were presented on mean +/- standard deviation (min–max) and categorical measurements results were presented in number (%). Significance of association between CT scan findings and the final diagnosis was done with the help of chi square test/Fischer exact test. The correlation of CT scan findings with final diagnosis was done by sensitivity, specificity, positive predictive value, negative predictive value and accuracy (diagnostic statistics). Statistical methods were framed with biostatistician consultation

RESULTS

In 60 cases of our study, 25 (41.6 %) were benign and 35 (58.4 %) were malignant neck lesions. There were 35 (60 %) male and 25 (40 %) female cases with a male to female ratio of 3 : 2 (male predominance). Lymph-node metastasis (20 %) were most common among the neck lesions in our study, followed by laryngeal malignancies (13.3 %) and then oral malignancies. Malignant lesions were more common in elderly, 61 - 70 years of age with a male to female ratio of 3 : 1 and benign lesions were common in 21 - 30 age group with a female to male ratio of 1.5 : 1. Parapharyngeal space (20 %) is the most common space to involve followed by visceral space (15 %).

Age Group (Years)	Females	(%)	Males	(%)	Total	(%)
< 10	1	4	1	4 %	2	8
11 – 20	2	8	2	8 %	4	16
21 – 30	4	16	2	8 %	6	24
31 – 40	3	12	1	4 %	4	16
41 – 50	2	8	1	4 %	3	12
51 – 60	1	4	1	4 %	2	8
61 – 70	1	4	1	4 %	2	8
71 – 80	1	4	1	4 %	2	8
Total	15		10		25	

Table 1. Age and Gender Distribution in Benign Lesions (N=25)

Age Group (Years)	Females	(%)	Males	(%)	Total	(%)
< 10	1	3	0	0	1	3
11 – 20	0	0	0	0	0	0
21 – 30	0	0	1	3	1	3
31 – 40	1	3	2	5.7	3	8.6
41 – 50	2	5.7	1	3	3	8.6
51 – 60	3	8.6	8	22.8	11	31.4
61 – 70	1	3	12	34.3	13	37.1
71 – 80	0	0	3	8.3	3	8.6
Total	8		27			

Table 2. Age and Gender Distribution in Malignancies (N = 35)

Neck Masses	Benign: Enhancing Nature		Degeneration/Necrosis		Bone Involvement		Vessel Involvement		Adjacent Space Involvement	
	Homogenous	Heterogenous	Negative	Positive	Absent	Present	Absent	Present	Absent	Present
Haemangiomas	2	0	2	0	2	0	2	0	1	1
Nasopharyngeal angiofibroma	0	1	1	0	0	1	1	0	1	0
Abscesses	1	4	4	1	4	1	4	1	3	2
Lymphadenopathy	1	1	1	1	1	1	1	1	2	0
Cystic hygroma	1	1	1	1	1	1	1	1	1	1
Branchial cyst	1	1	1	1	1	1	1	1	1	1
Nasopharyngeal adenoid	1	0	1	0	1	0	1	0	1	0
Parathyroid adenoma	0	1	0	1	1	0	0	1	1	0
X CN schwannoma	1	1	1	1	1	1	1	1	2	0
Post radiation necrosis	0	1	1	0	0	1	0	1	0	1
Arteriovenous malformation	1	0	0	1	1	0	1	0	1	0
V CN schwannoma	1	0	0	1	0	1	1	0	0	1
MNG nodular-goitre	1	1	1	1	1	1	1	1	1	1
Laryngocele	1	1	2	0	2	0	2	0	2	0
Total	**11**	**14**	**16**	**9**	**16**	**9**	**17**	**8**	**17**	**8**
	25		**25**		**25**		**25**		**25**	

Table 3. Characteristics of Benign Ones (N = 25)

Malignancies	Malignancies: Enhancing Nature		Degeneration/Necrosis		Bone Involvement		Vessel Involvement		Adjacent Space Involvement	
	Homogenous	Heterogeneous	Negative	Positive	Absent	Present	Absent	Present	Absent	Present
Laryngeal malignancies	2	7	3	6	4	5	9	0	3	6
Buccal malignancies	2	2	3	1	2	2	4	0	3	1
Nasopharyngeal malignancies	0	1	1	0	1	0	1	0	0	1
Submandibular malignancies	0	1	0	1	0	1	1	0	1	0
Oropharyngeal malignancies	1	1	1	1	1	1	0	2	1	1
Maxillary malignancies	0	1	0	1	0	1	1	0	1	0
Lymphoma	2	1	2	1	1	2	2	1	2	1
Paraganglioma/Carotid body tumour	0	1	1	0	1	0	1	0	1	0
Nodal metastasis	1	10	1	10	10	1	11	0	10	1
Papillary malignancies	1	0	1	0	1	0	0	0	1	0
Adenoid cystic malignancies	0	1	1	0	0	1	1	0	0	1
Subtotal	9	26	13	22	21	14	32	3	21	12
Total	**35**		**35**		**35**		**35**		**35**	

Table 4. Characteristics of Malignancies (N = 35)

Lesion Spaces	Positive		Negative		Total
	True	False	False	True	
1.Submandibular (SM)	4	0	0	56	60
2.Masticator (M)	4	1	0	55	60
3.Buccal (B)	4	0	2	54	60
4.Parapharyngeal (PP)	11	1	1	47	60
5.Carotid (C)	3	0	1	56	60
6.Parotid (P)	3	0	1	56	60
7.Pharyngeal-Mucosal (PMS)	4	1	1	54	60
8.Retropharyngeal (RPS)	1	0	1	58	60
9.Prevertebral (PreV)	1	1	1	57	60
10.Posterior-Cervical (PC)	2	0	1	57	60
11.Visceral (V)	8	1	1	50	60

Table 5. Sensitivity and Specificity of CT in Neck Lesions Diagnosis (N = 60)

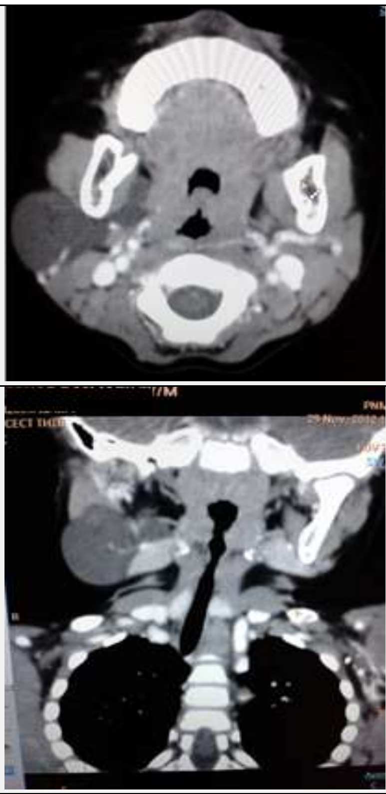

Figure 1. Cystic Hygroma in a 3-Year-Old Child

Figure 2. Right AEF Growth with PFS Invasion

Figure 3. Malignant Neoplastic Lesion of Parotid in an Elderly Male

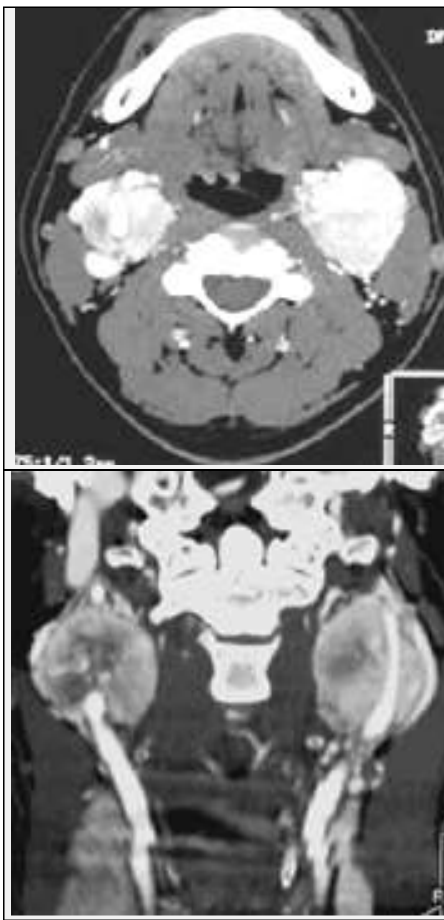

Figure 4. Bilateral Carotid Body Tumour

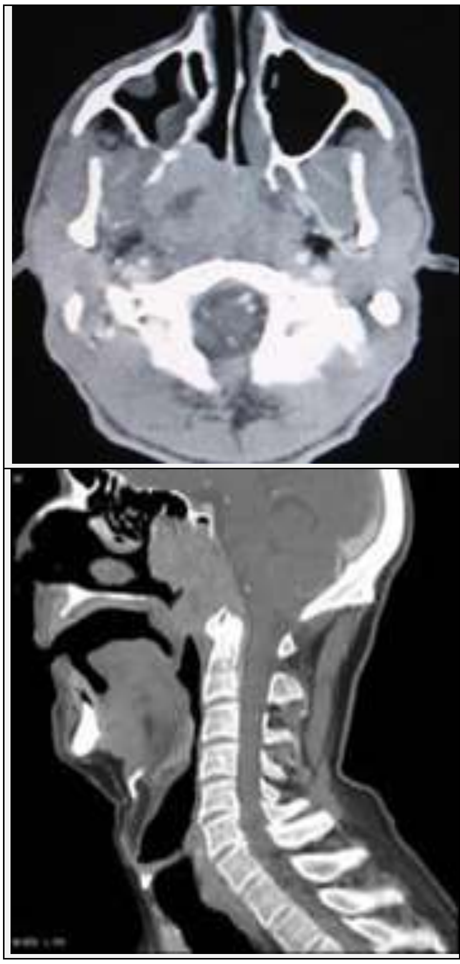

Figure 5. Nasopharyngeal Carcinoma

Figure 6. Retropharyngeal and Pretracheal Abscesses with Mediastinal Extension

Thin slice scanning with thinner reconstructions, MIP, SSD, MPR and curved reformatted images are the advantages of MDCT. CT has 100 % accuracy in bony involvement detection and 96 % accuracy in neck lesions diagnosis. Therefore, CT can accurately localise and characterise the neck lesions.

DISCUSSION

A study done by Ozkiris et al.[4] states that most of the benign lesions of neck occur in paediatric and young adults group and most of the malignant conditions occur in the elderly. In another study done by Ravimerhotra et al. (2005)[5] it showed that the prevalence of head and neck malignancy was highest in patients belonging to the 50 - 59 years age group. Cancers arise following progressive accumulation of genetic changes over a long period of exposure to carcinogens. Carcinogenic effects of tobacco, betel nut chewing habit and smoking was the reason behind higher prevalence of malignancy in this age group and prevalent among the population who were referred to this tertiary centre.

In our study, malignant lesions had male predominance with a male to female ratio of 3 : 2. Majority of the malignancies of neck were found among the males. This is because of their smoking and alcohol habits, which are the risk factors for head and neck malignancies. Male preponderance of malignant lesions in neck was also evident in a study done by Abhinandan Bhattajaree (2004).[6] Another study done by Ravi melhotra et al. (2005) on lesions of the head and neck region also reported a male preponderance.

Lymph node lesions are the most common neck lesion in our study - 13 cases (21.6 %) out of which 11 were malignant lymph-node and 2 were benign nodes. In one series done by Hoang JK et al. (2013)[7] it was found that the most common neck lesion encountered was lymph-node mass. The most common malignant lesion in the neck in their study was metastatic lymph nodes (35.71 %) followed by laryngeal carcinoma (17.8 %). In the study by Abhinandan Bhattajaree (2004) oropharyngeal cancer was most common malignancy followed by oesophageal cancers. In their study, cervical lymph nodes ranked sixth and laryngeal cancer ranked fifth. In another study by Hasan Altumbabic et al. (2008)[8] laryngeal cancers were most common (26.1 %) followed by cancers of oro-pharyngeal region.

Parapharyngeal space (20 %) is the most common space involved in our study followed by visceral space (15 %). This is because of metastatic lymph-nodes in this space and higher incidence of laryngeal carcinomas in our study. Adjacent space extension was seen in 12 (20 %) of malignant lesions and in 8 (13.3 %) cases of benign lesions.

13 lymph-nodes were seen in our study (7 parapharyngeal, 2 sub-mandibular, 3 posterior cervical space and 1 case of intraparotid node) 2 benign and 11 malignant lesions. A study by C. Eskey et al. (2000)[9] states that necrosis was more frequently seen in malignant lesions. Based on size and central necrosis, CT correctly differentiated benign and malignant lymph-nodes with 100 % sensitivity and specificity and an accuracy of 100 %. In a retrospective study by Kowalski et al. (1999)[10] CT scanning had accuracy of 91 %, a sensitivity of 86 % and a specificity

of 100 % in the detection of nodal metastases. Higher sensitivity and specificity in our study could be attributed to the lower sample size in this study. Another study by Steinkamp H J et al. (1994)[11] in cervical lymph-node metastasis using spiral CT had an accuracy of 96 % and they concluded that spiral CT was highly accurate to differentiate the metastatic lymph node from inflammatory nodes.

3 cases of posterior cervical lymph-nodes were detected in our study. CT was able to localise lymph-nodes accurately and characterise the lymph- nodes in the cases. A study done by Hansberger et al. (1991)[12] states that by typical characteristic displacements caused by a mass in the posterior cervical region, it is possible to show that the differential diagnosis of lesions of the posterior cervical space reflects the normal contents of the space. In their series most common lesion was metastatic lymph nodes followed by lymphoma.

12 cases of pre styloid parapharyngeal masses and 4 cases of retro styloid (carotid space) were diagnosed in our study. Out of 12, 7 (53.33 %) were reactive lymph-node masses and 5 were metastatic lymph-nodes. 2 cases of branchial cysts and 2 cases of cystic hygromas were encountered in the series, 2 cases of X CN schwannoma and 1 case of carotid body tumour were encountered in the series. CT was able to diagnose the lesion in 16 out of 16 cases with a sensitivity and specificity of 100 %.

In a study done by Lustrin et al. (2001)[13] the most common lesion in parapharyngeal space was salivary gland malignancy followed by squamous cell carcinoma metastasis and developmental lesions. In their study they could differentiate the paragangliomas and schwannomas based on enhancement patterns. A study done by Baker et al. (2008)[14] concluded that parapharyngeal space lesions, can be distinguished on CT by evaluating not only their inherent characteristics but also the surrounding fat planes and any displacement of the internal carotid artery. Baker, Burkhardt (2008)[12] conducted a study on surgical and CT examinations of 104 patients, each of whom presented with a parapharyngeal space mass and concluded that when dynamic scanning is used, a specific preoperative diagnosis can be made in 88 % of the patients.

3 cases of parotid lesions were seen in our study, 1 case of pleomorphic adenoma, 1 case of adenoid cystic carcinoma and 1 case of intraparotid lymph node. CT could accurately diagnose the lesions in all the 3 cases with sensitivity and specificity of 100 %. A study done by Shin K. H[15] reviewed CT findings of 58 cases of parotid gland tumours confirmed by surgery and histopathology and were retrospectively analysed who correctly recognized benign lesions in 38 and the CT diagnosis for malignancy was correct in 11 of 16 cases thus, concluding that irregularities in tumour margin and findings of extra-glandular extension are the most helpful indicators by which benign and malignant parotid tumours may be differentiated.

5 cases of pharyngeal mucosal lesions were diagnosed in our study. A case of adenoid, a case of angiofibroma, a case of carcinoma of nasopharynx, a case of carcinoma of tonsil and a case of carcinoma of base of tongue. We could accurately diagnose the cases with sensitivity and specificity of 100 %. In a study by Malard O et al. (2004)[16] in evaluating the usefulness of CT in oropharyngeal cancers, they found that sensitivity of CT for tumour extension was 82 %, predictive value for bone involvement was 67 %. In their study they found that clinical examination was poor in predicting the presence (54 %) or absence (56 %) of node involvement. Sensitivity of CT was 80 %, specificity 71 %, positive predictive value 67 %, and negative 83 %. In our study higher sensitivity and specificity could be attributed to lower sample size.

1 case of nasopharyngeal angiofibroma was diagnosed in our study, in a young adolescent male involving the pterygopalatine fissure and the nasopharynx and secondarily invading the ethmoid sinuses showing intracranial extension with characteristic intense vascular enhancement on contrast administration. This is consistent with study by K. V. Narayanaswamy et al.[1] in which 8 cases of juvenile nasopharyngeal angiofibroma were studied. All were adolescent males, and the lesion showed intense enhancement and intra cranial extension.

1 case of retropharyngeal abscess was diagnosed in our study. By CT, the lesion was correctly localised and characterised with sensitivity and specificity of 100 %. A study conducted by Micheal E Stone et al. (1999)[17] on correlation of CT versus clinical findings in retropharyngeal inflammatory process in children concluded that CT was a good imaging modality with an accuracy of 73.33 % in differentiating cellulitis from abscess. In their study, false positive rate was 11.4 % and false negative rate was 14.7 %. Higher sensitivity and specificity in our study could be because of smaller sample size.

9 cases of laryngeal carcinomas were encountered in our study. All the cases were accurately diagnosed with 100 % sensitivity and specificity. The accuracy of preoperative staging by high-resolution CT for glottic carcinoma was 75 % in a retrospective study by Zbaren et al. (2007).[2] The accuracy of CT staging was superior in the clinical staging, increased in the supraglottic and trans glottic lesions, the pre-operative staging accuracy was 91 % for supraglottic carcinoma and 87 % for trans glottic carcinoma. Higher accuracy of laryngeal carcinoma in our series could be because of the use of helical CT in this study.

We had a case of arteriovenous malformations (AVM), in our study, which was of a 18-year-old female patient who presented with facial asymmetry. There was hemi-mandibular hypertrophy because of diffuse involvement of left hemi-mandible causing expansion of the outer and inner cortices of left hemi-mandible.

Other patients in this category were that of bony involvement secondary to maxillary carcinoma, nasopharyngeal angiofibroma, buccal carcinoma and a case of nasopharyngeal carcinoma.

CT demonstrated bony changes in all the involved cases in our study with highest accuracy that were confirmed post-operatively. The benign lesions (V CN schwannoma, nasopharyngeal angiofibroma and arterio-venous malformation) caused bony expansion and remodelling rather than bony destruction and erosion. Whereas the malignant lesions (buccal carcinoma, nasopharyngeal carcinoma, adenoid cystic carcinoma, maxillary carcinoma and laryngeal carcinoma) caused bony erosion. The present study correlated with the study conducted by Iyer et al. (2004)[18] who states that benign tumours are slow growing and show bony expansion than bony destruction whereas malignant lesions and chronic granulomatous infections show bony destruction. In our study, MDCT detected both bony expansion and bony destruction in patients. The sensitivity and specificity of CT to detect bone erosion or destruction was 100 %. This is where the CT has definite advantage over the MRI. When malignant mass causes bone destruction, CT and MRI can be used as complimentary to each other, without the bias to one modality.

A study by Tomura N et al. (1993)[3] Three-dimensional computed tomography in the head and neck diseases with bony abnormalities on 32 patients was examined with a low dose radiation technique. Three-dimensional CT clearly delineated bony lesions in 27 of 32 patients. In another series by Brown, (1994)[19] CT confirmed bone invasion in all (100 %) patients. A series by Lell et al. (2000)[20-24] in their study mediated with radiological & histological pattern of bony involvement of oral cancers classified bone resorption modes into negative, erosive and invasive types and histological involvement as non-invasive, expansive and invasive types. They concluded that CT was extremely beneficial in pre-operative evaluation of tumour spread to bone and surrounding tissues.

There was an overall 96 % accuracy in diagnosing neck lesions in our study. Very few false positive cases were encountered in our study, one of them was of post radiation necrosis which was wrongly diagnosed as tumour recurrence.[25-28] There was enhancement of the lesion and hence, was wrongly diagnosed as tumour recurrence but was histo-pathologically proved as radiation necrosis. In general, with the evolution of MDCT, and the use of coronal and sagittal reformatted images, the sensitivity of localising neck mass has gone up.

CONCLUSIONS

The neck lesion localisation and its characteristics determination has significantly improved because of computed tomography. CT is the choice for initial evaluation, pre-operative planning, biopsy targeting, and post-operative follow-up because of its fast, well tolerated, and readily available nature. Bone erosions and expansion were accurately determined by a CT scan. CT scan can accurately delineate the disease that provides a definite pre-operative diagnosis, planning radiotherapy ports and post therapy follow up. The advantages are faster scan acquisition, less susceptibility to deleterious artefacts from patient motion, ability to be performed in patients with implanted electrical devices. However, histopathology still remains the gold standard as CT is not 100 % accurate.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
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