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The Role of Medical Physics to Diagnose Head and Neck Cancer

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Abstract: Medical physics has added great advances to diagnose head and neck cancer particularly for imaging. There are many imaging techniques to diagnose the disease such as CT, MRI, Endoscopy, Ultrasound etc. CT is the most useful technique among these for the detection of patients with head and neck cancer. The sensitivity of CT is greater than 80% due to its high contrast and spatial resolution. It gives more information for the assessment of initial stage tumors in the patients of head and neck cancer. CT is based on the principal of x-rays generation and detectors are moved around the patient and the data is obtained digitally from detectors and feed it to the computer. Computer processes this data and re-contracts the image with high contrast. Results showed that CT scan is promising technique to evaluate tumor and bone erosion in head and neck area.

Key words: Computational Tomography · Head and Neck Cancers · Rhabdomyosarcoma and leiomyosarcoma

INTRODUCTION

Since the discovery of X-rays, the invention of computed tomography (CT) is considered to be the greatest innovation in the field of radiology. This cross-sectional imaging technique provided diagnostic radiology with better insight into the pathogenesis of the body, thereby increasing the chances of recovery. In 1979, G.N. Hounsfield and A.M. Cormack were awarded the Nobel Prize in medicine for the invention of CT. In 1990s the spiral Computed Tomography was introduced and afterwards it had become a popular technique. Recently multidetectors Computerized Tomography is used in spite of Spiral CT. It is also some times said that Multidetector -row CT, MDCT, multislice CT and also volume MDCT [1, 2]. A 41 years old lady was the first person who's computed tomography was performed. Lobe tumor was observed in this CT. It took more than half day in scanning [1]. Computer technology has come a long way since then and now allows for astonishingly rapid imaging of human anatomy that would have been unthink-able three decades ago.

A beam of X-ray is used in CT that in turn forms an attenuated image by the use of computer by measuring radiations with the help of detector. Computer analyzes data that is taken by detector. Subsequently, image is reconstructed and is displayed on monitor. Then mathematical equations are used to proceed for the cross sectional anatomy of image [3].

In United States (US), 4-5% head and neck cancers was accounted as the malignant disease in 2008. Head and neck squamous cell carcinoma (HNSCC) comprises the vast majority of head and neck cancer (HNC). Oncologic imaging plays an important role in head and neck cancers as imaging findings can aid significantly detection, staging, restaging and therapy response assessment of these tumors. Accurate staging at the time of diagnosis is critical for selection of the appropriate treatment strategy [4].

The vast majority of CT applications in head and neck cancer related to its squamous cell carcinoma. The head and neck cancer include diagnosis of distant metastases, identification of synchronous, detection of carcinoma of unknown primary and detection of residual or recurrent disease. Emerging applications are precise delineation of the tumor volume for radiation treatment planning, monitoring treatment and providing prognostic information [5].

Diagnosis of a head and neck cancer is usually achieved by a combination of patient history, physical examination and either nasopharyngoscopy and/or laryngoscopy with directed biopsies. Panendoscopy may

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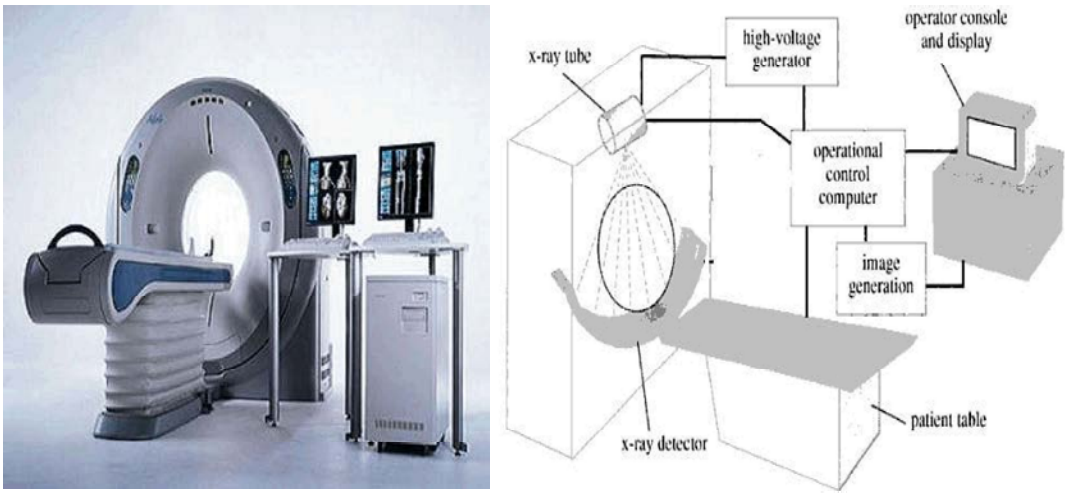

Fig. 1: CT System and its block diagram [10]

be necessary to reveal the extent of a tumor. Morphologic imaging with computed tomography (CT) is often performed either prior to panendoscopy to noninvasively assess the aerodigestive tract or afterwards to provide information about primary tumor size, infiltration, involvement of surrounding structures and regional nodal involvement [6, 7]. There is growing evidence, however, that these modalities have limitations in their diagnostic accuracy. CT imaging relies on criteria of contrast-enhancement patterns and nodal size for detection of lymph node metastases which are not specific and may escape detection of metastases within normal size lymph nodes [8, 9].

In this paper, we discuss the investigation of the role of CT scanning for the detection of head and neck cancer. Patients of different ages are diagnosed head and neck cancer by CT scanning.

MATERIAL AND METHODS

Computed Tomography provides the best opportunity to evaluate the physiological function in head and neck and also gives information at anatomic level. It is the highly sensitive and mature technique that can be frequently used for the detection of head and neck cancer. Most of the patients are diagnosed of head and neck cancer by CT that detects the recurrent thyroid, carcinomas, caramel base new plasma and evaluation of unknown primary tumor site staging of head and neck cancer and tumor surveillance.

The data of four patients is taken by Aquilion (TSX-101A) 16-slice scanning system. The Aquilion-16 works fast and easy to operate. The main benefit of this system is operated automatically. Computer, Gantry assembly and operating console are its basic parts. The photograph of the CT scanning system and its schematic is illustrated in Figure 1.

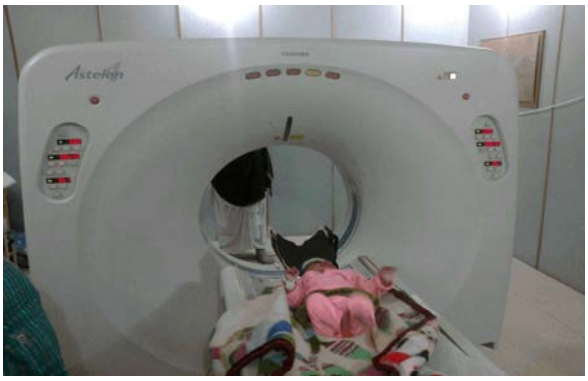

Fig. 2: Gantry of system [10]

The primary rule of CT describes the projection of subject, that are used and it gives the interior structure of the object. The picture is made from the data of image. The density difference is recorded for different tissues. This is obtained using X-rays by multiple angles. The data is obtained by the detector. CT-Gantry is the major and biggest component of CT and it is the heart of CT scanning system. It consists of the couch, collimators, X-rays tube and a high voltage generator [11]. Slip rings are used for continuous rotating of gantry. The device CT-gantry can rotate around the patient at an angle of 30º. The aperture of gantry is in the range of 50 cm to 85 cm in general. The main role of large aperture of gantry is to save from damage. X-ray tube, generator to produce high voltage, detectors and collimators are the main parts of gantry. The photograph of gantry of system is shown in Figure 2.

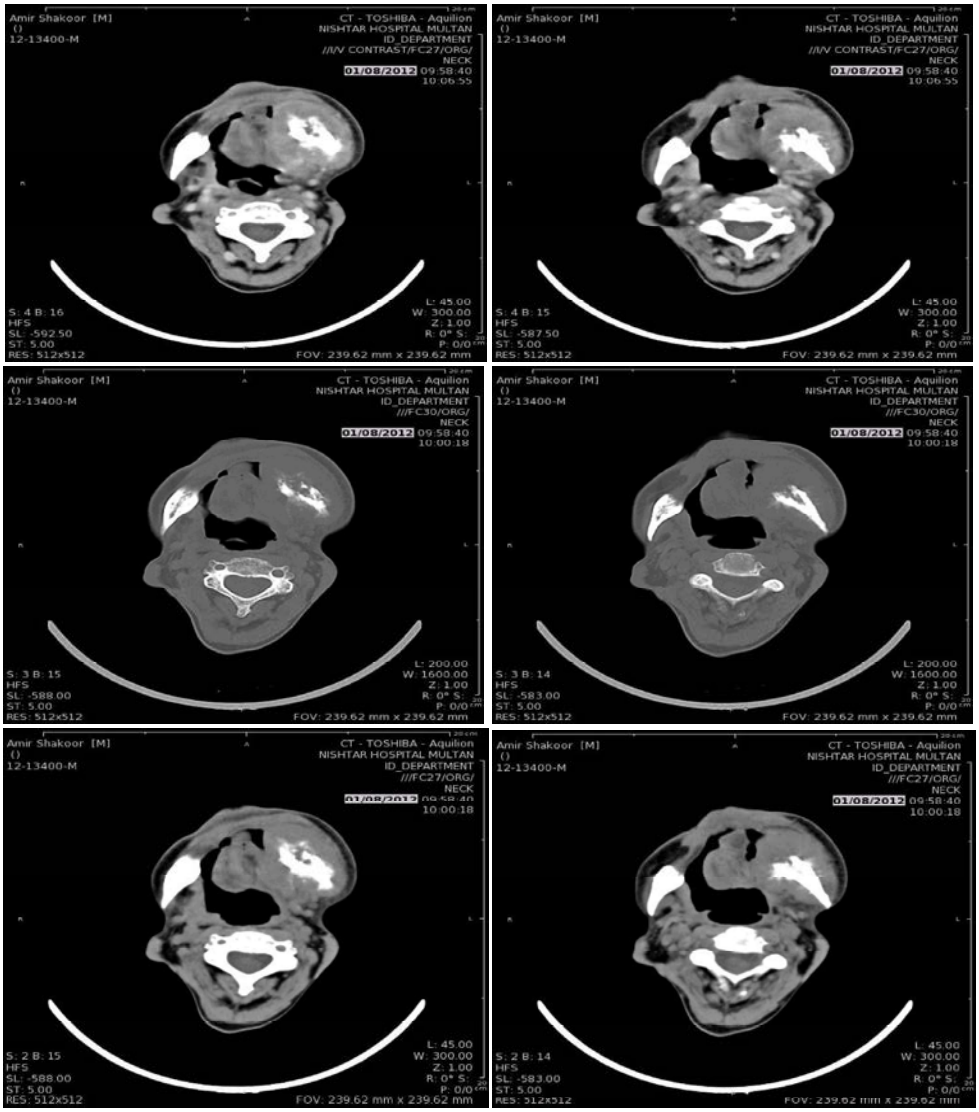

Fig. 3: Axial images of a 30 years old patient are obtained before and after contrast

RESULTS AND DISCUSSION

Neck Cancer: CT scanning is very useful technique for the evaluation of recurrent rhabdomyosarcoma in the neck as it is more technique than any other technique due to appearance of recurrent rhabdomyosarcoma. Figure 3 describes the CT images of neck cancer of a 30 years old patient.

The patient has swelling in the left side of his neck. He has also difficulty in swallowing so physician referred the patient for CT scan. From the CT scanning results the case of recurrent rhabdomyosarcoma is diagnosed. The soft tissue density mass is measured approx. 5.6 × 5.3 cm as seen clearly on the left side of face. Mass with heterogeneous contrast enhancement infiltrating left masseter, medial pterygoid and left half of the floor of mouth and subcutaneous tissue of the left cheek, mass is also eroding maxilla and mandible on the left side. There is no definite vascular invasion seen and mucosal thickening of right maxillary sinus is also seen. Beside that visualized sections of brain is appeared normal. Rhabdomyosarcoma with recurrent mass involving left side of face resulting in underlying bone erosion and extension into ipsilateral adjacent muscles is diagnosed.

Another patient of 42 years old with neck cancer is also diagnosed. She has different symptoms than the previous patient but she is also diagnosed leiomyosarcoma in her neck. The CT images are illustrated is Figure 4.

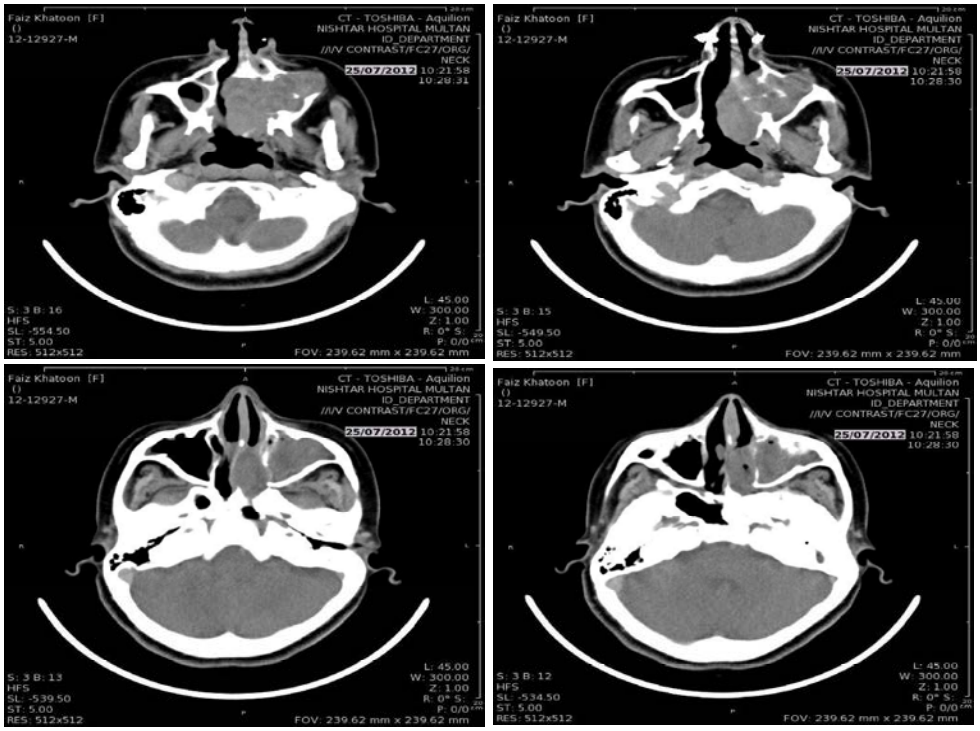

Fig. 4: Axial images of a 42 years old patient are obtained before and after contrast

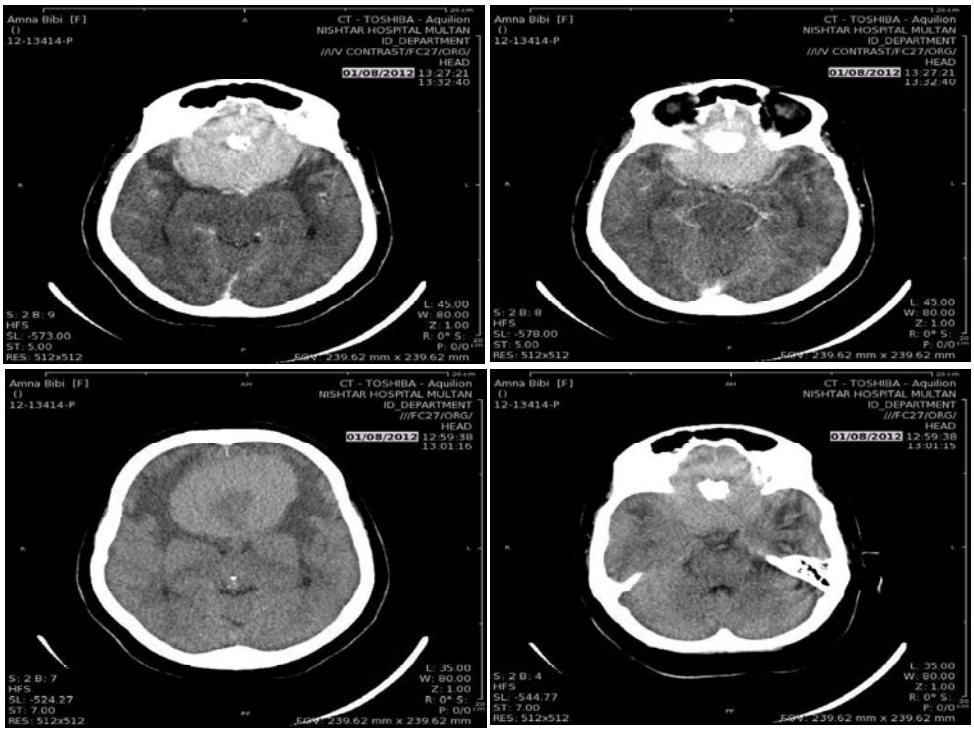

Fig. 5: Multiple 5 & 10 mm axial images with & without intravenous contrast

The patient has vision loss of left side so the physician referred the patient for CT scan. She was diagnosed leiomyosarcoma and there is expansile heterogeneously enhancing mass measuring 6.1 cm × 5.3 cm in coronal sections seen involving left maxillary sinus, ethmoidal sinus and left nasal cavity. The mass is

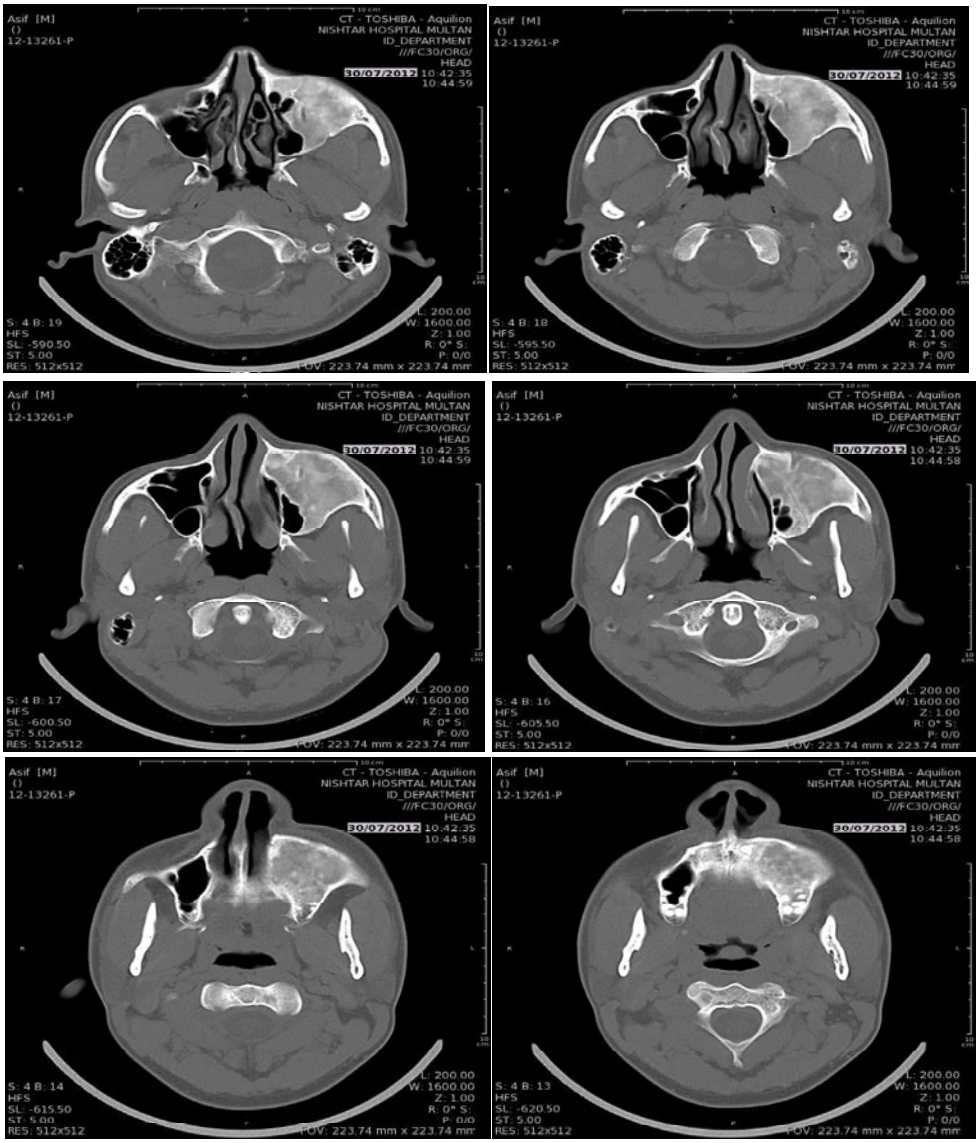

Fig. 6: Multiple 5 & 10 mm axial images with & without intravenous contrast

extending superiorly into sphenoidal, left frontal sinus and inferiorly up to soft palate and caused erosion of anterior. There is mucosal thickening of right maxillary sinus. It is very common case of leiomyosarcoma and heterogeneously enhancing mass involving left maxillary, ethmoid, sphenoid, frontal sinuses, extending into nasal cavity / nasopharynx and left sided cheek with bone erosion is seen.

Head Cancer: The evaluation of GBM and Meningioma in the head cancer is scanned by CT as it is more sensitive technique than any other technique. Figure 5 shows the CT images of head cancer of a 5 years old patient.

The patient has headache, vomiting, decreased vision and memory loss hence the physician referred the patient for CT scan. Well defined, hyperdense, intensely contrast enhancing mass lesion with central area of necrosis measuring 6.8 cm × 5.6 cm is clearly seen in the midline bifrotnal region with significant perifocal vasogenic edema that is causing pressure effects on frontal horns of lateral ventricles resulting in its splaying. There is generalized effacement of cortical sulcal spaces representing generalized brain edema. Mass is causing erosion of roof of orbit and is extending into ethmoid and nasal bone after eroding vicinity. No hyperostosis of underlying bone is seen. There is no evidence of intra tumoral hemorrhage,

calcification and no intraventricular extension seen. CT is much better technique for the evaluation of GBM and Meningioma.

Another patient of 17 years old with head cancer is also diagnosed and his CT images are illustrated is Figure 6.

The doctor referred the patient for CT scan because he has swallowing in the left side of his face and headache. There is an expansile lesion with ground glass matrix measuring 4.7 cm × 4.7 cm in saggital section involving maxillary bone and left alveolar ridge left and inferior orbital wall. The left maxillary sinus is smaller in size and there is no evidence of conal, intra and extra conal lesion seen. There is no evidence of ICH and visualized section of cerebrum and cerebellum are normal. Hence the findings are suggestive of mono-ostotic fibrousdysplasia.

CONCLUSION

Computed tomography (CT) is the standard imaging technique used for the detection of patients with head and neck cancer. It gives internal information at a high spatial resolution; therefore it is used for the assessment of initial stage tumors in the patients of head and neck cancer. The quality of image is proportional to dose and CT number OR atomic no. of the different tissues. This shows that CT is the most effective technique of finding head and Neck cancer.

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REFERENCES

1. Mahesh, M., 2009. MDCT Physics: The Basics – Technology, Image Quality and Radiation Dose. New York: Lippincott Williams & Wilkins Publishing.
2. Sanjay, S., Geoffrey, D.R. and Mannudeep, K.L. (2006). *MDCT: A practical Approach*. New York: Springer Publications.
3. Bushong, S.C., 2004. Radiologic science for technologists. (8th edition). USA: Elsevier Mosby Publishing.
4. Jemal A., R. Siegel, E. Ward, Y. Hao, J. Xu, T. Murray and M.J. Thun, 2008. Cancer statistics, 2008, CA: Cancer Journal for Clinicians, 58(2): 71-96.
5. AkramAl-Ibraheem andreas Buck, Bernd Joachim Krause, Klemens Scheidhauer andMarkus Schwaiger. 2009. Clinical applications of FDG PET and PET/CT in head and neck cancer. Hindawi Publishing Corporation, Journal of Oncology, pp: 13.
6. Chung-Hwan Baek, Man Ki Chung, Han-Sin Jeong, Young-Ik Son, Jeesun Choi, Yoon-Duck Kim, Joon Young Choi, Hyung-Jin Kim and Young Hyeh Ko, 2009. The clinical usefulness of 18F-FDG PET/CT for the evaluation of lymph node metastasis in periorbital malignancies, Korean Journal of Radiology, 10(1): 1-7.
7. Jong-Lyel Roh, Nam-Kyung Yeo, Jae Seung Kim, Jeong Hyun Lee, Kyung-Ja Cho, Seung-Ho Choi, Soon Yuhl Nam and Sang Yoon Kim, 2007. Utility of 2-[^{18}F] fluoro-2-deoxy-d-glucose positron emission tomography and positron emission tomography/computed tomography imaging in the preoperative staging of head and neck squamous cell carcinoma, Oral Oncology, 43(9): 887-893.
8. Arie Gordin, Avishay Golz, Marcello Daitzchman, Zohar Keidar, Rachel Bar-Shalon, Abraham Kuten and Ora Israel, 2007. Fluorine-18 fluorodeoxyglucose positron emission tomography/computed tomography imaging in patients with carcinoma of the nasopharynx: diagnostic accuracy and impact on clinical management, International Journal of Radiation Oncology Biology Physics, 68(2): 370-376.
9. Kim, M.R., J.L. Roh, J.S. Kim, J.H. Lee, K.J. Cho, S.H. Choi, S.H. Choi, S.Y. Nam and S.Y. Kim, 2007. Utility of 18Ffluorodeoxyglucose positron emission tomography in the preoperative staging of squamous cell carcinoma of the oropharynx, European Journal of Surgical Oncology, 33(5): 633-638.
10. Hsieh, J., 2003. Computed tomography: principles, design, artifacts and recent advances. USA: SPIE Press.
11. Wilbur L. Reddinger, M.S.R.T. 2005. CT Instrumentation & Physics. The Jorunal of America, 25(4): 151-152.