Original Article
Received on 11.06.2016, **Accepted on** 25.06.2016

Indian Journal of Pathology: Research and Practice
Volume 5 Number 3, September - December 2016
DOI: http://dx.doi.org/10.21088/ijprp.2278.148X.5316.7

Sensitivity, Specificity and Accuracy of Computed Tomography Guided Fine Needle Aspiration Cytology in Intra-Thoracic Lesions

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Abstract

Background: Computed Tomography (CT) guided Fine Needle Aspiration Cytology (FNAC) is an established, safe, reliable and accurate procedure for cytological diagnosis of any intra-thoracic lesion which is deep seated and inaccessible by Ultrasonography (USG). *Aims & Objectives:* To study the sensitivity, specificity and diagnostic accuracy of CT guided FNAC and to correlate its diagnosis with histopathology (HP) in intra-thoracic lesions. *Materials & Methods:* CT guided Fine Needle Aspirations (FNA) were performed in 63 patients with various intra-thoracic lesions during May 2009 to December 2011. Their cytological diagnosis was compared to HP diagnosis. True and false (positive and negative) data was analyzed to measure sensitivity, specificity and diagnostic accuracy of CT guided FNAC. *Results:* Out of 63 cases, adequate material was aspirated in 59 cases (Sample adequacy 93.7 %.) so remaining 4 cases were excluded from study. Maximum cases were from Lung (39) followed by Mediastinum (9), Pleura (6) and Vertebral & Para-spinal region (5). FNAC was diagnostic in all 59 cases which had adequate material. Among which, 40 (67.8 %) cases were malignant and 19 (32.2%) were benign. HP correlation was available in 37 (62.7%) cases. HP diagnosis was different from FNAC diagnosis in only 3 (8.1%) cases. Diagnostic accuracy of CT guided FNAC was 91.8% with 90.3% sensitivity and 100% specificity. *Conclusion:* Having high sensitivity, specificity and diagnostic accuracy, CT guided FNAC is an OPD based safe, reliable and accurate diagnostic procedure for various intra-thoracic lesions which are inaccessible by USG. It helps the clinician to select the treatment modality avoiding costly surgical biopsies and unnecessary thoracotomy for diagnostic purposes.

Keywords: CT Guided; FNAC; Intra-Thoracic; Sensitivity; Specificity; Accuracy.

Introduction

Improvement in various radiological techniques has made diagnostic process more accurate and allows more precise localization of deep seated intra-thoracic lesions [1]. Such few techniques are Ultrasonography (USG), Computed Tomography (CT) Scan, Magnetic Resonance Imaging (MRI) Scan, Fluoroscopy etc. But clinical and radiological data alone neither give definite diagnosis nor differentiate between benign, malignant or non-neoplastic lesions. So FNAC under imaging guidance is the preferred method for tissue diagnosis in intra-thoracic lesions [2]. Although USG guidance is the first choice due to its mobility, portability, rapidity, easy availability and zero radiation exposure, it poorly visualizes some intrathoracic lesions of lung and mediastinum due to obscuring effect of air [3]. So, CT is the preferred imaging modality in all such cases and also when USG guidance failed to yield adequate material in first try [4]. With CT guidance, extremely small lesions in the lung can be sampled and needle can be swung freely with the respiratory or involuntary movements in contrasts to USG guided FNAC which produce fixed systems which may causes trauma to the underlying tissue. Thus, by determining accurate needle placement in deep seated intrathoracic lesions, CT guided FNAC can safely avoid injury to other vital structures [5]. However some associated risk and complications like pneumothorax, hemorrhage,

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hemoptysis, pneumomediastinum, hemothorax, air embolism, needle tract tumor seedling etc. should not be underestimated [6,7,8]. Though CT guided FNAC has its own limitations like, its time consuming, comparatively costly and has radiation exposure, it is still considered safe, reliable and accurate procedure if performed with a team approach in the presence of a pathologist as he can guide the radiologist to different areas of lesion, such as periphery instead of central necrotic area of solid lesions and so multiple needle passes can be prevented [4,9]. Contraindications like unconscious or uncooperative patients, respiratory failure, bleeding disorders, intractable coughing, pulmonary hypertension etc. should also be kept in mind before doing FNAC [10]. The main objectives of present study are: (1) To study the sensitivity, specificity and diagnostic accuracy of CT guided FNAC and to correlate its diagnosis with histopathology in intra-thoracic lesions. (2) To diagnose and differentiate various benign and malignant intra-thoracic lesions. (3) To assist the clinician in selection of suitable medical, surgical or palliative treatment for the patient.

Material and Methods

The study was carried out in total 63 patients having intrathoracic masses referred to Pathology Department of Smt. NHL Municipal Medical College and its attached hospitals in Ahmedabad, Gujarat, India between May 2009 to December 2011 after approval from institutional ethics committee. Prior radiological examination were done and patients found to have intra-thoracic masses which were inaccessible by USG were subjected to CT guided FNAC after taking informed consent, proper history and ruling out any absolute contraindication. With strict aseptic precautions, a 20-22 gauge long spinal needle with stylet was introduced under CT guidance. During needle insertion, patient was asked to hold the breath and needle tip location within the lesion was ascertained by CT. Four to five rapid passes were made within the lesion, following which the stylet was removed and aspiration was done by attaching a 10-20 ml syringe to the needle and smears were prepared. Some smears were air dried while some were fixed in 95% ethyl alcohol and stained with Haematoxylin & Eosin (H&E) and Papanicolaou stains. Special stains like Gram's, Ziehl–Neelsen(ZN) were used whenever necessary. For subsequent Histopathological Examination (post-surgical), specimens were fixed in 10% formalin, appropriate sections were taken, processed in automatic tissue processor, cut by microtome and slides were prepared. Slides were stained by H & E stain and mounted with DPX. Finally, FNAC and HP diagnosis were compared, analyzed and results were interpreted.

Results

We have performed CT guided fine needle aspirations from various intra-thoracic lesions from total 63 patients including 34 males (54%) and 29 females (46%) in the age range of 33 to 88 years in Smt. NHL Municipal Medical College and its attached hospitals in Ahmedabad, Gujarat, India from May 2009 to December 2011. The study was followed by Histopathological Examination (HPE) in 37 cases. CT guided FNAC were done form various intra-thoracic sites like Lung, Mediastinum, Pleura and Vertebral & Para-spinal regions. Out of these 63 aspirations, adequate material was aspirated in 59 cases, while 4 aspirations were inadequate (acellular or blood only), so they were excluded from the study. FNAC was diagnostic in all 59 cases having adequate material. Among which, 40 were malignant and 19 were benign. Various parameters are displayed in Table 1.

Table 1: Various Parameters in CT Guided FNAC

Parameters	Number of Cases	%
Total Cases	63	100
Male	34	54
Female	29	46
Adequate	59	93.7
Inadequate (so, excluded from study)	04	6.3
Cytological Diagnosis	**59**	**100**
Benign	19	32.2
Malignant	40	67.8
Histopathological Diagnosis Available	**37**	**62.7**
Benign	06	10.2
Malignant	31	52.5
Histopathology Diagnosis not available	**22**	**37.3**

Table 2: CT Guided FNAC Diagnosis in Various Intra-Thoracic Lesions with Histopathological correlation

Site of FNAC	*Category of Lesions*	*Cytological Diagnosis*	*No. of Cases*	*%*	*Histopathological Diagnosis* *Cyto-Histo Concordant Cases*	*Cyto-Histo Discordant Cases*	*Cyto-Histo Correlation Not Available*
LUNG (39 cases)	Malignant (29)	Squamous cell carcinoma (SCC)	14	23.7	12	0	2
		Adenocarcinoma	7	11.9	6	0	1
		Metastatic carcinoma	5	8.4	2	0	3
		Small cell carcinoma	2	3.4	0	0	2
		Large cell carcinoma	1	1.7	1	0	0
	Benign (10)	Granulomatous Inflammation	7	11.9	0	2(SCC)	5
		Abscess	2	3.4	2	0	0
		Hamartoma	1	1.7	1	0	0
MEDIASTINUM (9 cases)	Malignant (5)	Non-Hodgkin's lymphoma (NHL)	4	6.8	3	0	1
		Thymoma	1	1.7	1	0	0
	Benign (4)	Granulomatous Inflammation	3	5.0	0	0	3
		Reactive lymphadenitis	1	1.7	0	1(NHL)	0
PLEURA (6 cases)	Malignant (4)	Mesothelioma	4	6.8	3	0	1
	Benign (2)	Solitary fibrous tumor	1	1.7	1	0	0
		Abscess	1	1.7	1	0	0
VERTEBRAL & PARA-SPINAL (5 cases)	Malignant (2)	Metastatic carcinoma	2	3.4	0	0	2
	Benign (3)	Granulomatous Inflammation	2	3.4	0	0	2
		Abscess	1	1.7	1	0	0
	TOTAL CASES		**59**	**100**	**34**	**3**	**22**

Table 3: Comparative Analysis between FNAC and Histopathology Diagnosis

FNAC Diagnosis		**Histopathology Diagnosis** **Available**		**Not Available**
Cytological Diagnosis	**No. of Patients**	*Benign*	*Malignant*	----
Benign	19	06 (TN)	03 (FN)	10
Malignant	40	00 (FP)	28 (TP)	12
		06	31	
TOTAL	**59**	**37**		**22**

Table 4: Comparison of Sensitivity, Specificity and Diagnostic Accuracy of Present Study with Other Studies [5,15, 20-24]

Studies	**Year of Publication**	**No. of Cases**	**Sensitivity %**	**Specificity %**	**Accuracy %**
Stanely et al	1987	458	96.6	100	96.6
Van Sonnenberg et al	1988	150	82.7	100	82.7
Haramati et al	1995	32	84.0	100	81.0
Mohammad M et al	2001	184	95.6	100	97.0
JP Singh et al	2004	34	92.6	100	85.3
SMK Nahar Begam et al	2007	119	91.2	100	93.7
Sarker RN et al	2011	100	93.8	100	96.0
Present Study	---	59	90.3	100	91.8

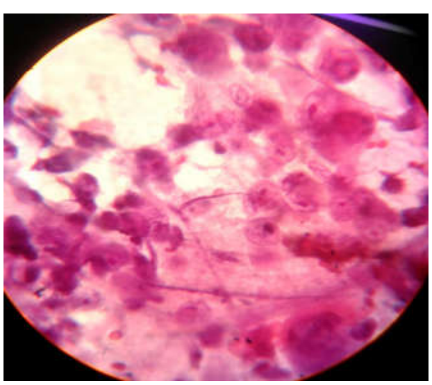

Fig. 1: Squamous Cell Carcinoma (H&E, × 400)

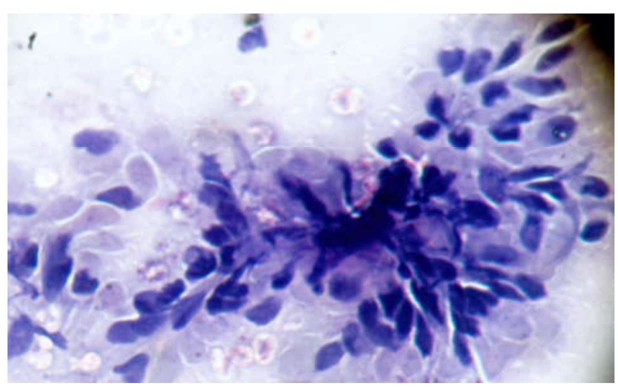

Fig. 2: Adenocarcinoma (PAP, × 400)

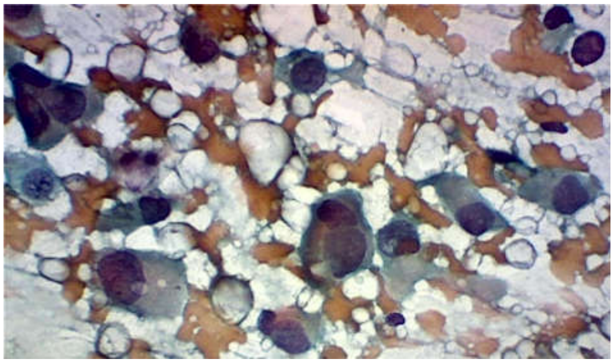

Fig. 3: Mesothelioma (PAP, × 400)

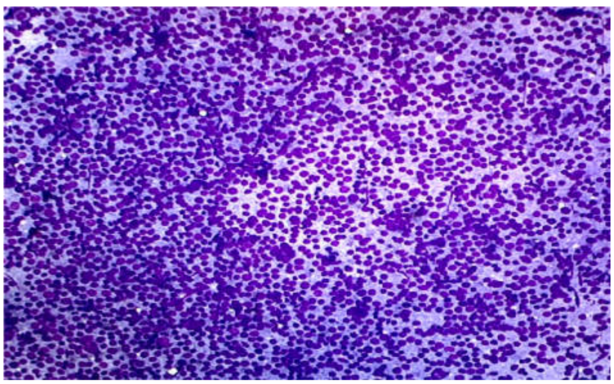

Fig. 4: Non-Hodgkin's Lymphoma (H&E, × 100)

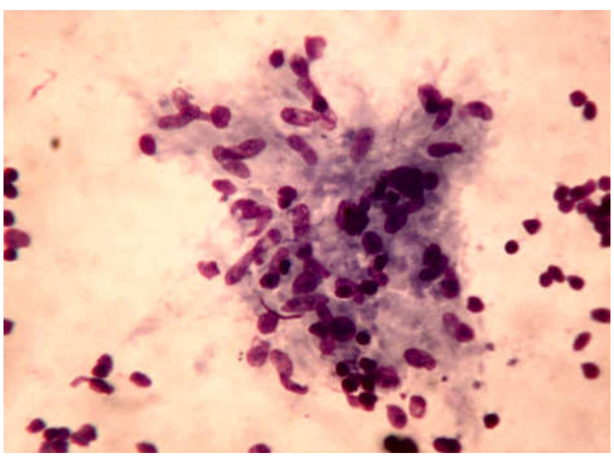

Fig. 5: Granulomatous Inflammation (H&E, × 400)

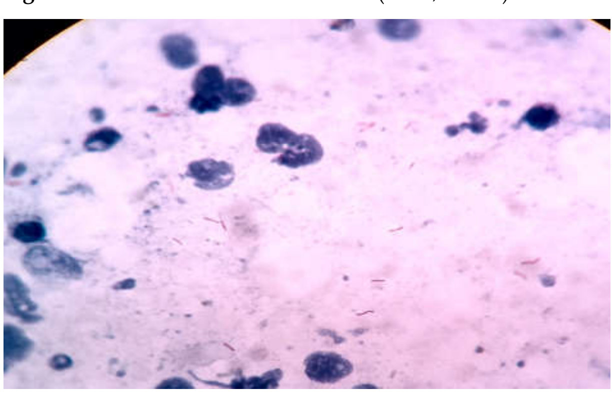

Fig. 6: Acid Fast Bacilli in Granulomatous Inflammation (ZN Stain, × 1000)

Malignant lesions diagnosed were various carcinomas of lung including Non-Small cell carcinoma (Squamous cell carcinoma (SCC), Adenocarcinoma, Large cell carcinoma) and Small cell carcinoma. Others were Metastatic carcinoma of different organs, Non-Hodgkin's lymphoma, Thymoma and Mesothelioma. Benign lesions were Hamartoma of lung, Solitary fibrous tumor of pleura, Granulomatous inflammation, Abscess and Reactive lymphadenitis. Details of FNAC diagnosis in all intra-thoracic lesions with their histopathological correlation is tabulated in Table 2 and photomicrographs of some lesions are shown in Figures 1 to 6.

Pneumothorax, pulmonary haemorrhage, haemoptysis and pain at the puncture site were the main complications observed in 13 (20.6%) patients during or after the procedure. Among which 6 patients had pneumothorax, 4 had haemorrhage in surrounding tissue and 3 had haemoptysis, but all these being mild in nature, required just observation or no treatment at all. HP correlation was available in 37 (62.7%) cases while not available in 22 (37.3%) cases. Out of 37 cases, HP diagnosis was different from FNAC diagnosis in 3 (8.1%) cases; two from lung and one from mediastinal lymph node. Both were diagnosed as benign on FNAC (Granulomatous Inflammation & Reactive lymphadenitis) while malignant on HPE (Squamous cell carcinoma & Non-Hodgkin's lymphoma) respectively. With regard to malignancy, a comparative analysis was done between cytological and histopathological diagnosis as shown in Table-3 with following observations. True Positive (TP)-28 cases, True Negative (TN)-6 cases, False Positive (FP)-0 cases and False Negative (FN)-3 cases.

So, following are the overall Accuracy, Sensitivity and Specificity measurements.

Accuracy: It measures the *degree of veracity* of diagnostic test on a condition

(Benign or Malignant).

= (TP+TN) ÷ Total **×** (100)

= (28+06) ÷ 37 × (100)

= **91.8 %**

Sensitivity: The ability of a test to *detect* disease (here, Malignancy) when it is present.

= TP ÷ (TP+FN) **×** (100)

= 28 ÷ (28+3) × (100)

= **90.3 %**

Specificity: The ability of a test to *exclude* disease (here, Malignancy) when it is not present.

= TN ÷ (TN+FP) × (100)

= 6 ÷ (6+0) × (100)

= 100 %

Discussion

The main purpose of this study is to know the sensitivity, specificity and diagnostic accuracy of CT Guided FNAC in various intra-thoracic lesions by correlating Cytological findings with Histopathological (HP) findings. CT guided aspirations were performed in all 63 patients and yielded adequate material in 59 patients (Sample adequacy 93.6%) while 4 patients had inadequate material (6.3%). Various studies have shown the rate of inadequate sampling to vary from 8.8 to 25.4% [11,12]. From total 40 malignant cases, maximum 29 malignant cases (49.1%) were reported from Lung followed by 5 from Mediastinum (8.4%), 4 from Pleura (6.8%) and 2 from Vertebral & Para-spinal region (3.4%). The commonest malignancy reported in all intra-thoracic lesions was Squamous cell carcinoma of lung with 14 cases (23.7%) while the commonest benign lesion was Granulomatous inflammation with 12 cases (20.3%) which was comparable to other studies [13,14].

Among malignant lung lesions, Squamous cell carcinoma was the commonest malignancy comprising 48.2% of cases (14/29) followed by Adenocarcinoma with 24.1% cases (7/29). These were comparable to various studies among which some show higher incidence of squamous cell carcinoma over adenocarcinoma [13,14] while some shows vice a versa [15,16]. Literature shows that 70% of the primary lung cancers are non-small cell carcinomas, while small cell carcinomas are around 20% [17]. In this study, we have observed higher incidence of non-small cell carcinoma (91.7% of all primary lung carcinoma [22/24]) but incidence of small cell carcinoma was comparatively lower 8.3%.

Among benign lung lesions, granulomatous lesion was the comments comprising of 70% of all benign lung lesions (7/10). 5 out of 7 granulomatous lesions were confirmed as tuberculosis by finding Acid Fast Bacilli (AFB) in ZN stain and 2 doubtful cases not showing AFB on ZN stain, proved to be SCC on HPE.

Among lesions from pleura, mesothelioma was the commonest malignancy while solitary fibrous tumor and abscess were the benign ones.

Out of 9 Mediastinal lesions, Non-Hodgkin's lymphoma was the most common malignancy which is consistent with other study [18]. Other lesions were Thymoma, granulomatous inflammation and one case of Reactive lymphadenitis which later proved to be NHL on HPE.

Out of 5 vertebral and Para-spinal lesions, 2 were metastatic carcinoma and others were granulomatous inflammation and abscess.

One interesting finding is that most of the granulomatous inflammations were confirmed as tuberculosis by finding AFB on ZN stain, similar to study done by J. Baby et al [19].

In 22 cases, HP correlation was not available mainly because, some benign lesions like tuberculosis were treatable by medicine, so biopsy was not advised. In some malignant lesions, either the patients didn't come for follow up or they have been referred to higher center for advance treatment or surgery is not advised because some malignancies like Small cell lung carcinoma and Spinal metastasis do well respond to chemotherapy or radiotherapy. In 3 cases, HP diagnosis was different from the FNAC diagnosis. Among which, 2 cases from lung diagnosed as 'Granulomatous inflammation' (Benign) on FNAC due to attached necrotic component, proved to be 'Squamous cell carcinoma' on HPE.

The third one from Mediastinal lymph node, diagnosed as 'Reactive lymphadenitis' (Benign) on FNAC due to technically suboptimal smears, proved to be 'Non-Hodgkin's lymphoma' (Malignant) on HPE. The present study showed that the diagnostic accuracy of CT guided FNAC in intra-thoracic lesions was 91.8% with 90.3% sensitivity and 100% specificity which are comparable to other studies as shown in Table 4 [5,15,20-24].

Conclusion

CT guided Fine Needle Aspiration Cytology is reliable, diagnostic and accurate in 91.8% of cases with 90.3% sensitivity and 100% specificity in present study. It plays an important role in diagnosing and differentiating various benign and malignant intra-thoracic lesions and assists the clinician to select the treatment modality avoiding costly surgical biopsies and unnecessary thoracotomy for diagnostic purposes. Therefore, CT guided FNAC should be used as a first line procedure for diagnosis of deep seated intra-thoracic lesions.

Acknowledgements: Nil

Funding: None

Conflict of Interests: None declared

References

1. Reddy VB, Gattuso P, Abraham KP, Moncada R, Castell MJ. Computed tomography guided fine needle aspiration biopsy of deep seated lesions: a four year experience. Acta Cytol 1991; 35: 753-6.
2. Parajuli S, Tuladhar A, Basnet RB. Ultrasound and computed tomography guided fine needle aspiration cytology in diagnosing intra-abdominal and intra-thoracic lesions. Nepal Med Coll J 2011; 1: 17-21.
3. Suzanne Le P Langlois, Steve Chryssidis. Imaging methods for guidance of aspiration cytology. In: Orell SR, Sterrett GF: Fine needle aspiration cytology, 5th edition 2012, Edinburg: Churchill Livingstone; p 28-31.
4. Yankelevitz DF, Vazquez M, Henschke CI. Special techniques in transthoracic Needle biopsy of pulmonary nodules. Radiol Clin North Am 2000; 38: 267–279.
5. Van Sonnenberg E, Casola G, Ho M, et al. Difficult Thoracic Lesions: CT-guided Biopsy Experience in 150 cases. Radiology 1988; 167: 457-461.
6. Herman PG, Hessel SJ. The diagnostic accuracy and complications of closed lung Biopsies. Radiology 1977; 125: 11-14.
7. Berquist TH, Baily PB; Cortese DA, Miller WE. Transthoracic needle biopsy: Accuracy and complications in relation to location and type of lesion. Myo clin Proc 1980; 55: 475-481.
8. Roussel F, Dalion J, Benozio M. The risk of tumoral seedling in needle biopsies. Acta Cytol 1989; 33: 936-9.
9. Conces DJ Jr, Schwenk GR, Doering PR, Glant MD, Thoracic needle biopsy: Improved Results utilizing a team approach. Chest 1987; 91: 813-816.
10. Hansell DM: Interventional techniques. In: Armstrong P, Wilson AG, Dee P. (Eds): Imaging of diseases of the chest, St. Louis, Mosby, 1995; 2: 894-912.
11. Kline TS. In: Handbook of Fine Needle Aspiration Biopsy Cytology, 2nd edition 1988. New York: Churchill Livingstone; p14.
12. Kowalewski J, Sir J, Dancewicz M, Swiniarska J, Pepliñski J. Fine needle aspiration biopsy under CT-guidance-usefulness in diagnosis of malignant lung tumors. Pneumonol Alergol Pol. 2004; 72: 177–80.
13. Arslan S, Yilmaz A, Bayramgürler B, Uzman O, Nver E, Akkaya E. CT-guided transthoracic fine needle aspiration of pulmonary lesions: Accuracy and complications in 294 patients. Med Sci Monit. 2002; 8: 493–7.
14. Prasad R, Kushwaha RA, Mukherjee PK, Nath J, Agarwal PK, Agarwal GN. Accuracy and safety of unguided transthoracic fine needle aspiration biopsy in the diagnosis of intrathoracic lesions. Indian J Tub. 1994; 41: 167–70.
15. Nahar Begum SMK, Ekram ARMS, Uddin D, Islam QT, Alam MM, Hoque MA, et al. Ultrasound and computed tomographic guided fine needle aspiration cytology of intrathoracic lesions. TAJ. 2007; 20: 110–5.
16. Madan M, Bannur H. Evaluation of fine needle aspiration cytology in the diagnosis of lung lesions. Turk J Pathol. 2010; 26: 1–6.
17. Wu X, Groves FD, McLaughlin CC, Jemal A, Martin J, Chen VW. Cancer incidence patterns among adolescents and young adults in the United States. Cancer Causes Control. 2005; 16: 309–20.
18. Desai F, Shah M, Patel S, Shukla SN Fine needle aspiration cytology of anterior mediastinal masses. Indian J Pathol Microbiol. 2008; 51(1): 88-90.
19. J Baby, P George. Computed tomography guided fine needle aspiration cytology of thoracic lesions: A retrospective analysis of 114 cases. IOSR Journal of Dental and Medical Sciences 2014; 13(1): 47-52.
20. Stanley JH, Fish GD, Andriole JG, et al. Lung lesions: Cytological diagnosis by fine needle biopsy. Radiology 1987; 162: 389-91.
21. Haramati LB.CT-guided automated needle biopsy of the chest. AJR 1995; 165: 53-55.
22. Mohammad GM. CT guided fine needle aspiration cytology in the diagnosis of thoracic lesions. JIMA 2001; 99(10): 1-5.
23. Sing JP, Garg L, Setia V. Computed tomography guided transthoracic needle aspiration cytology in difficult thoracic mass lesions not approachable by USG. Ind J Radiol Imag 2004; 14(4): 395-400.
24. Sarker RN, Rabbi AF, Hossain A, Quddus MA et al. Computed tomography guided transthoracic fine needle aspiration cytology in the diagnosis of sonographically non-approachable intrathoracic masses – a study of 100 cases. J Dhaka Med Coll. 2011; 20(1): 25-31.