THE DIAGNOSTIC ACCURACY, SENSITIVITY AND SPECIFICITY OF FINE NEEDLE ASPIRATION CYTOLOGY IN EVALUATING THYROID MASSES AT MOI TEACHING AND REFERRAL HOSPITAL

BY

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DECLARATION

Declaration by the candidate

This thesis is my original work and has not been presented for a degree in any other University. No part of this thesis may be reproduced without a prior written permission of the author and/or Maseno University.

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DEDICATION

I dedicate this research thesis to all Pathologists, Cytopathologists, Biomedical Scientists,

Laboratory Technologists and Technicians and finally Patients with Thyroid Pathologies.

ABSTRACT

Thyroid masses are common surgical presentations with a worldwide prevalence of 4–7% in the general adult population. Africa, specifically Kenya is not excluded from these surgical conditions. The vast majority of adult thyroid nodules are benign neoplasm's, however, less than 10% are malignant, which makes it important to screen the nodules in order to offer appropriate surgery and avoid unnecessary surgery for benign nodules. It is preferred to operate only on those patients with suspicion of malignancy, while strict patient follow-up is necessary in dealing with benign cases. Fine needle aspiration cytology (FNAC) is known to play a pivotal role in the screening and management of thyroid swellings. FNAC is done in an increasing number of patients presenting with thyroid masses at the Moi Teaching and Referral Hospital, however its findings are yet to be incorporated into the management and planning of these masses. The aim of this study was to assess the diagnostic accuracy of FNAC in evaluating thyroid nodules at the Moi Teaching and Referral Hospital in order to establish a basis of whether or not to incorporate its findings in the management of these masses pre-operatively. This was a retrospective study where FNAC and corresponding histological evaluation findings of 118 patients aged 17-88 years who had a pre-operative FNAC and subsequently a thyroid resection for definitive histological diagnosis between January 2007 and December 2014 were randomly sampled and accessed from the archives of MTRH and compared for concordance and discordance. Of the 118 FNAC, 17 (14.40%) were inadequate to make a diagnosis, 14(11.86%) were suspicious for malignancy, and 78 (66.1%) were benign while 9 (7.62%) were malignant. The benign cases consisted predominantly of colloid goiter (54.54%) whereas the malignant ones consisted predominantly of papillary carcinomas (5.08%). The concordance, false positive and false negative rates were 90.80%, 3.44% and 5.74% respectively. The accuracy, sensitivity, specificity, positive predictive value and negative predictive values of FNAC were 90.80%, 54.54%, 96.05%, 66.66% and 94.58% respectively. There was a significant agreement between the two tests (p= 0.34). FNAC of thyroid is accurate and has a low rate of false-negatives and false-positives diagnoses hence can be adopted and relied upon in evaluating thyroid nodules pre-operatively. Use of FNAC reduces the rate of unnecessary surgeries, the cost of health care and the risks associated with surgeries, resulting in better outcome of patients care.

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LIST OF ABBREVIATIONS AND ACRONYMS

The following abbreviations and acronyms were used;

FN	False negative
FNAC	Fine needle aspiration cytology
FP	False positive
FVPTC	Follicular variant of papillary thyroid carcinoma
IREC	Institutional review and ethics committee
KNH	Kenyatta national hospital
MTRH	Moi teaching and referral Hospital
NPV	Negative predictive value
PPV	Positive predictive value
PTC	Papillary thyroid carcinoma
SPSS	Statistical package for social sciences
STN	Solitary thyroid nodule
TDC	Thyroglossal duct cyst
TFT	Thyroid function test
TN	True negatives
TP	True positives
TSH	Thyroid stimulating hormone
USG	Ultrasonography

DEFINITION OF KEY TERMS

The following terms were used in this thesis;

Accuracy: This is the probability that a randomly selected subject is correctly diagnosed by the test

Benign tumors: Tumours that do not infiltrate into surrounding tissues

False negatives: Those cases in which FNAC failed to confirm malignancy while histopathology showed malignancy

False positives: Those cases in which FNAC showed malignancy but histopathology showed no evidence of malignancy

Malignant tumors Tumors that are cancerous and invade surrounding tissues

Negative predictive value This is the probability that a person who has tested negative on a diagnostic test actually does not have the disease

Positive predictive value: This is the probability that a person who has tested positive on a diagnostic test actually has the disease

Sensitivity This is the probability that a person with disease will correctly test positive based on the diagnostic test

Specificity: This is the probability that a person without a disease will correctly test negative based on the diagnostic test

Suspicious: cases which showed some features of malignancy but the findings were not sufficient to make a conclusive diagnosis

True negatives Those cases in which FNAC was negative for malignancy and histopathology also confirmed benign disease

True positives: Those cases in which both FNAC and histopathology showed malignancy

Tumour/Neoplasm: An abnormal mass of tissue, the growth of which exceeds and is uncoordinated with that of normal tissue and persists in the same excessive manner after cessation of the stimuli which evoked the changes

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CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Thyroid nodules are common clinical manifestations, which are endemic in mountainous regions, where the soil, water and food supply contain little iodine (Elahi *et al.,* 2005). The reported prevalence globally is 4–7% in the general adult population and 0.2% - 1.2% in children (Ridgway, 1986). The vast majority of adult thyroid nodules are benign neoplasm's, however, less than 10% are malignant, which makes it important to screen the nodules in order to offer appropriate surgery and avoid unnecessary surgeries for benign nodules (Nyonyintono *et al.,* 2011). Increased suspicion of malignancy is associated with male gender, females of ages less than 15 years and greater than 45 years, history of radiation exposure, and personal or family history of conditions known to be associated with thyroid cancer (Network, 2008). Thyroid nodules are 4 times more common in women than in men (Vander *et al.*, 1968) and increase in frequency with age and with decreasing iodine intake (Reiners *et al*., 2004). The gender disparity is perhaps explained by the hormonal influences of both estrogen and progesterone, as increasing nodule size and new nodule development have been demonstrated to be related to pregnancy and multiparity (Jonklaas *et al*., 2006).

Neoplasms of thyroid have a wide phenotype spectrum ranging from benign follicular lesions to the violently anaplastic carcinoma (Abdul-Jabar & Lynn, 2004). The most common diagnoses and their approximate distributions are colloid goiters, cysts, and thyroiditis in 80%; benign follicular neoplasms in 10- 15%; and thyroid carcinoma in 5% (Mistry *et al*, 2011). In sub-Saharan Africa, where Kenya is situated, most thyroid nodules are a result of Iodine deficiency (Watters & Wall, 2007). Iodine deficiency is defined as a median urinary iodine concentration less than 50 μg/L in a population (Watters & Wall, 2007). These iodine deficiency nodules are treated by giving iodinated oil like Lipiodol or Brassiodol. Within 3 months of treatment, 98% of these nodule regress and do not require surgery but iodine

(Watters & Wall, 2007) The main goal of evaluating thyroid nodules is to identify and surgically treat patients with malignancies, while identifying and avoiding surgery in those with benign, asymptomatic thyroid nodules (Orell *et al.* 2005). The distinction of benign from malignant nodules is important as preference for operation is on those patients with suspicion of malignancy, while strict patient follow-up is recommended in dealing with benign cases, thus avoiding unnecessary surgeries in patients with benign lesions like thyroiditis (Fernandes *et al*, 2009). The diagnosis and distinction of benign lesions from malignant is by clinical means, FNAC and histopathological examination of the biopsy. However, these methods differ in many occasions and therefore this study was carried out with a view of correlating FNAC and corresponding histological diagnoses findings. Fine needle aspiration cytology is a technique for obtaining cellular material for cytological examination, which is minimally invasive, and provides rapid diagnosis. However, it does not preserve its histological architecture (Obaseki, 2009). Fine needle aspiration cytology is unable to differentiate follicular and Hurthle cell carcinomas from their benign counterparts because it cannot establish the presence of capsular and/or vascular invasion (Theoharis *et al.*, 2009).

Histological examination of the thyroid is the most accurate way of determining the pathology. However, it is expensive since it requires prior preparations and long procedures like surgery anesthesia, hospitalization and sometimes even over treatment (McCaffrey, 2000). Surgery involvement exposes patients to the risks of anesthesia, postoperative infection, and the possibility of tumor seeding. A percentage of patients may require overnight admission to the hospital and extra time away from work (Bailey *et al.*, 2006). Fine needle aspiration cytology has greatly improved the clinical management of thyroid nodules with previous studies showing the sensitivity range of 80 to 98 percent and specificity from 58 to 100% (Shepherd *et al*., 2006). The accuracy of FNAC depends highly on the experience of the operator and the cytopathologist reading it and in very experienced hands the false

negatives are as low as 1- 6% (Mehanna *et al.*, 2009). An Ethiopian study on FNAC showed a 96.9% accuracy for diagnosing simple goiter (Bekele, 2007). A study done at King Khalid University hospital in Saudi Arabia found that FNAC on thyroid nodules had a sensitivity of 71.4% and a specificity of 96.4% (Khairy & Murshid, 2004). Chandanwale *et al., (*2012) showed a sensitivity and specificity of 90% and 100% respectively. While a Study in Oman done by Al-Yaarubi *et al*.,(2011) showed a poor result of 16% sensitivity.

At MTRH, patients presenting with thyroid masses are subjected to surgery even in the presence of a benign FNAC diagnosis, meaning that clinicians and surgeons do not have confidence in FNAC of thyroid because its accuracy is yet to be assessed. This study aimed to demonstrate the effectiveness of FNAC (in the form of sensitivity, specificity and accuracy) in the diagnosis of different thyroid lesions by comparing its findings with those of corresponding histological diagnosis in order to provide a basis of incorporating its findings in the pre-operative management of thyroid nodules. The current study was based at MTRH which serves the western region of Kenya where the soils lack iodine and therefore, thyroid masses are rampant as a result of iodine deficiency.

1.2 Statement of the Problem

Thyroid masses remain a problem of enormous magnitude all over the world. The vast majority of adult thyroid nodules are non-neoplastic (benign), however fewer than 5% are neoplastic (malignant) and require surgical intervention (Bakhos *et al*., 2000). The large number of benign thyroid masses relative to the small number of the malignant ones creates a clinical dilemma; how to manage patients with thyroid nodules that most probably are benign (Esmaili & Taghipour, 2012).

The problem in clinical practice is to distinguish reliably the few malignant tumors from the many harmless nodules so that a definitive pre-operative tissue diagnosis of malignancy allows planning of appropriate surgery and relevant patient counseling.

FNAC is done on an increasing number of patients presenting with thyroid masses at MTRH, however its accuracy has not been established and therefore nodules are not appropriately investigated pre-operatively. Thus the decision regarding the type of operation to be performed is always subjective and sometimes unnecessary.

1.3 Study Objectives

1.3.1 Main objective

To evaluate the accuracy and diagnostic performance of fine needle aspiration cytology in the diagnosis of thyroid masses at Moi Teaching and Referral Hospital, Eldoret Kenya.

1.3.2 Specific objectives

i. To determine the cytological patterns of thyroid pathologies at MTRH.
ii. To determine age and gender distributions of thyroid pathologies at MTRH.
iii. To determine the accuracy of fine needle aspirate cytology by comparing its findings with those of corresponding histological evaluation findings at MTRH

1.4 Research Questions

i. What are the cytological patterns of thyroid masses at MTRH?
ii. What are the distributions of thyroid masses with regard to age and gender at MTRH?

1.4.1 Hypothesis

iii. Ho: There is no agreement in diagnostic accuracy between FNAC of thyroid and histological test.

1.5 Justification and Significance of the Study

The low incidence of thyroid malignancies despite the high prevalence of thyroid nodules necessitates a screening tool to determine which patients require surgical management. In most clinical set ups including MTRH, patients presenting with thyroid nodules and masses are subjected to FNAC and thereafter to surgery for histological evaluation so as to confirm the definitive diagnosis. Not all patients with thyroid enlargement require surgical management.

Local evidence of the diagnostic accuracy of FNAC performed on thyroid nodules would allow appropriate management of thyroid nodules, and avoidance of unnecessary thyroidectomies which are expensive (for our low resourced health environment) and associated with a lot of morbidity and mortality. This would also aid pre-operative planning regarding type of operation to be performed. FNAC is not only cheap but also less invasive and can easily be done at the outpatient department. Hence this study has the potential to contribute to the improvement of the management of thyroid nodules at the MTRH.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

The thyroid gland is situated at the front of the throat, below the larynx (Adam's apple), and comprises two lobes that lie on either side of the windpipe (Williams & Bannister, 1995). The thyroid gland secretes hormones that regulate many metabolic processes, including growth and energy expenditure (Williams, 2008). The thyroid gland is prone to several very distinct problems, some of which are very common. These problems include; the production of hormones (too much, or too little), increased growth of the thyroid, causing compression of important neck structures or simply appearing as a mass in the neck, the formation of nodules or lumps within the thyroid which are worrisome for the presence of thyroid cancer, and those which are cancerous (Baskin *et al.*, 2001).

2.2 Cytological Patterns of Thyroid Pathologies

A study done at Cairo University, Egypt on 296 cases of thyroid nodules that had diagnostic thyroid FNAC reported 98 (33.1%) cases as benign, 40 cases (13.5%) as follicular lesion of undetermined significance, 49 cases (16.5%) as follicular neoplasm, 30 cases (10.1%) as suspicious for malignancy, 58 cases (19.5%) as malignant, and 21 cases (7.1%) as unsatisfactory. Nodular hyperplasia represented the majority of benign cases (89.8%), while papillary carcinoma was the most frequent malignant lesion (72.4%) (Sinna & Ezzat, 2012).

Esmaili and Taghipour (2012) conducted a study in Iran on 1639 aspirates of thyroid masses, 151 (9.2%) cases were unsatisfactory, the remaining 1488 cases were classified as 1054 (64.3%) benign, 128 (7.8%) malignant, and 306 (18.66%) suspicious. Benign lesions included 996 (94.4%) cases of multinodular goiter, 55 (5.2%) cases of Hashimoto's and chronic non-specific lymphocytic thyroiditis, 2 (0.2%) cases of sub-acute thyroiditis, and 1 (0.1%) case of Riedel's thyroiditis.

Likhar *et al* (2013) in India studied 234 cases of thyroid masses and found that the most common thyroid lesions were benign in 221 (94.4%), followed by malignant 6 (2.6%), indeterminate 3 (1.3%), and inadequate 4 (1.7%). Out of 221 (94.4%) benign thyroid lesions, 33% were simple colloid goiter, 27.6% goiter with cystic changes, 16.28% nodular colloid goiter, 10.41% lymphocytic thyroiditis, 4.53% thyroglossal cyst, 4.07% colloid goiter with hemorrhage, 0.9% were follicular adenomas, and others formed 3.17%. Out of 6 (2.6%) malignant thyroid lesions, 3 were papillary carcinomas and 3 were follicular neoplasm's.

Mamoon *et al* (2013) at Islamabad conducted a study on 327 patients who had undergone FNAC of thyroid swellings. The results were interpreted as inconclusive in 18 (5.5%), benign in 230 (70.3%), (207 colloid goiter, 19 thyroiditis, and 4 cysts), suspicious in 64 (19.6%) and malignant in 15 (4.6%) 9 papillary carcinomas, 1medullary carcinoma, 2 anaplastic carcinoma and 3 lymphoploriferative disorders.

Kumar *et al* (2014) conducted a study in India of 96 patients who underwent FNAC diagnosis the results showed 74 (77%) with benign lesions and two cases (2%) with malignancy. Another 4 cases were suspicious for malignancy. Out of remaining 16 patients, 6 cases were non diagnostic and 10 cases were of atypical cells of undetermined significance (ACUS). Out of all benign lesions, Colloid Goiter was the most frequently seen lesion (58 cases) and cystic lesion in 4 cases with unsatisfactory result group of lesions. The malignant lesions showed anaplastic or poorly differentiated papillary carcinoma.

Nepali *et al* (2013) analyzed 50 cases of FNAC thyroid swellings in Nepal, and found 37 (74%) cases were non neoplastic and 13 (26%) cases were neoplastic. Among the non neoplastic thyroid swellings, colloid goiter was the commonest, 27 (54%) cases, followed by nodular goiter which was 6 (12%) and multinodular goiter 4 cases (8%). Among the

neoplastic thyroid swellings, Papillary carcinoma was the most common 7(14%) followed by Follicular neoplasm 4 (8%) and 2 cases of Follicular Adenoma.

Alta villa *et al* (1990) examined 2433 lesions of the thyroid gland by FNAC in Turkey. Cytopathology classified 66.91% of the aspirates as benign, 10.76% as thyroiditis, 4.89% as suspected neoplasm's, 1.31% as positive for malignancy and 16.11% as unsatisfactory.

2.3 Age and Gender Distribution of Patients with Thyroid Pathologies

A study on gender distribution of thyroid lesions showed a female preponderance, with 86.3% females and 13.7% males and a male: female ratio of 1:7. It found a significant association between benign and malignant thyroid disease with gender, and was higher towards the female side (Likhar *et al.*, 2013).

Chandanwale *et al* (2012) conducted a study in India on 150 patients with thyroid nodules to evaluate the accuracy of FNAC in diagnosis of thyroid nodules, the ages of the patients ranged from 18-65 years. Commonest age group was 21-40 years (49%) with preponderance of benign lesions. Females (66.6%) were more commonly affected than males (33.3%).

Kumar *et al* (2014) in India studied 96 patients who underwent FNAC of thyroid nodules. Out of these, 90 (93.75%) were females while 6 (6.25%) were males. Age of the patients ranged from 15-65 years. 62 patients (64%) were seen in the age ranging from 21-55 years.

Allan (2012) in Scotland did a study on 325 patients who had FNAC diagnosis. 90 were diagnosed with a thyroid malignancy. Of these 90 patients, 58 were females and 32 were males. The male: female ratio is 1: 2. The age range of patients diagnosed with malignancy was 17-91 and the average age 56.

Gupta *et al* (2010) carried out a study in India on 75 patients who presented with solitary thyroid nodules: 6 (8%) were male and 69 (92%) were females. Age of the patients ranged from 22 to 58 years with mean age of 38.7 years. Fifty one (68%) patients were from plain areas and 24 (32%) were residents of hilly areas. Commonest presentation was neck swelling in 60 (80%) of the patients. Duration of complaints ranged from six days to twenty years and mean duration was 1.7 years.

Taghipour *et al* (2013) carried out a study in Iran on 271 subjects who met the inclusion criteria. Patients' age ranged from 23 to 78 years, women comprised 81.5% of the subjects. Mean age of the subjects with benign and malignant pathologies did not differ significantly. After classification of age into categories it was revealed that majority of subjects in the malignant group were below 30 and older than 60 years when compared with individuals in the benign group. The female to male ratio was 4.5: 1. Males presented with malignant nodules more than females. On the other hand, subjects in the two groups did not differ significantly with respect to the presence of thyroid enlargement on examination, number of thyroid nodules, and TFT. The sizes of the thyroid nodules were significantly different between the two groups; nodules of less than 2 cm were more likely to be malignant, whereas those greater than 5 cm were usually of benign pathology.

Bamanikar *et al* (2014) carried out a study in India on the spectrum of thyroid lesions and found an incidence of female: male ratio of 8.6:1. The younger female patients (21-40 years) were in the majority and the mean age was 38.6 years. Malignant thyroid lesions were detected by FNAC in 12 patients, between ages 20-70 years with a mean age of 45.3 years. The females outnumbered the males.

A study done in India by Sejalkumari *et al* (2014) on 137 cases, found out a sex distribution of 117(85.4%) females and 20(14.5%) males. This was a female: male ratio of 5.8:1. The ages ranged from 18-65 years. The maximum numbers of cases were between 35-50years.

2.4 The diagnostic Accuracy of Fine Needle Aspiration Cytology

A study in India by Gulia *et al* (2011) compared the results of FNAC with histopathology , FNA showed overall diagnostic accuracy of 92.3% with specificity of 90.0% , sensitivity of 100% for malignant lesions, positive predictive value of 100% for malignancy and negative predictive value of 90.5%.

Beneragama *et al* (2006) analyzed the FNAC reports and histopathology reports of 158 patients at the University of Sri Jayewardenepura Sri Lanka with thyroid diseases and reported that FNAC had an acceptable validity in the diagnosis of thyroid diseases by means of high specificity (86.74%), sensitivity (84.05%), positive predictive value (84.05%), and negative predictive value (86.74%.

A study done in Taiwan by Tseng *et al* (2008) evaluated the results of 1064 FNACs obtained from 737 patients, of which 98 underwent subsequent thyroid surgery. The accuracy, positive predictive value, and negative predictive value of FNAC were 94.9%, 94.4%, and 95.0%, respectively. They concluded FNAC as a sensitive and specific method for the pre-operative screening of thyroid nodules.

A study by Bamanikar *et al* (2014) at Padmashree Patil Medical College, Hospital and Research Center, India reported a sensitivity of 50%, specificity of 100%, positive predictive value of 100%, negative predictive value of 93.8% and accuracy of 94.2%.

A study by Pandey *et al* (2012) in India on the diagnostic performance of FNAC achieved a sensitivity, specificity, diagnostic accuracy, positive predictive value and negative predictive

value of 57.14, 90, 80.28, 70.58 and 83.33%, respectively. Overall cytohistological concordance in all categories was 80.28% and discordance 19.71%. Of the discordant cases, false positives accounted for 11.60% and false negatives for 8.11%.

In Nepal, Bhatta *et al* (2012) reported an accuracy of 90 % with a sensitivity of 85.7 %, specificity of 92.3 %, false negative rate of 14.28% and false positive rate of 7.69%.

Mahar *et al* (2005) at the Aga Khan University Hospital, Karachi-Pakistan reported a FNAC sensitivity of 98%, specificity of 70%, positive predictive value of 91%, negative predictive value of 93% and diagnostic accuracy of 91%. They concluded that FNAC has got high sensitivity in picking up malignancy and also diagnostic accuracy.

A study by Alta villa *et al* (1990) in Turkey yielded a sensitivity of 71.43%, specificity of 100% and an accuracy of 95.09%. They recommended thyroid FNA as an important preoperative diagnostic tool.

A study by Muratli *et al* (2014) on the effectiveness of FNAC in the evaluation of thyroid nodules by comparing the results with histopathologic evaluation yielded a sensitivity of 87.1% and specificity of 64.6%. The positive and negative predictive values and accuracy rates were 76.1%, 79.5%, and 77.3%, respectively.

2.4.1 Correlations of FNAC findings with those of corresponding histological evaluations.

Gupta *et al* (2010) compared FNAC findings of 75 patients in India with histopathological findings. Fourty five cases were diagnosed as colloid nodular goiter and benign cystic lesions by FNAC. On histopathological examination, 39 of these cases were non neoplastic lesions, 3 were papillary carcinoma and 3 were follicular adenomas. 30 cases were diagnosed as neoplastic lesions (follicular neoplasm, hurthle cell lesions, papillary carcinoma, and

suspected malignancy) by FNAC. Three of these cases were non neoplastic lesions, 12 were benign neoplastic lesions, 12 were carcinoma, and 3 cases of suspected malignancy were diagnosed as hashimoto's thyroiditis on histopathological examination.

Bagga and Mahajan (2010) conducted a study in India on a total of 252 patients who had FNAC of thyroid. Out of these, 223 were female patients, while 29 were males. Age of the patients ranged from 6 to 75 years. All of these patients subsequently underwent thyroidectomy, and histopathological examination of the specimens was performed. The FNA cytology results were then compared with the corresponding histological diagnoses. The FNAC results were inadequate in 4 (1.6%), benign in 228 (90.5%), suspicious in 17 (6.7%), and malignant in 3 (1.2%). The histopathological findings of 32 cases that underwent surgery were benign in 25 and malignant in 6. The malignant cases comprised of papillary carcinoma (50%), follicular carcinoma (33.3%), and medullary carcinoma (16.7%).

A study done in India by Bhattacharya *et al* (2008) on 288 cases of thyroid swellings aspirated for FNAC, 249 samples were adequate for reporting and 39 cases (13.5%) were inadequate for reporting. The majority of the cases reported cytologically were non neoplastic in 197 cases, followed by indeterminate, 27 cases and malignant lesions 25 cases. Surgical samples were available in 32 of the 197 cases diagnosed as non-neoplastic lesions by cytology. In 25 (78.1%) cases, histological findings were consistent with the cytology results. 3 turned out to be benign neoplasm’s and the remaining 4 cases showed malignant histology. Of the 27 indeterminate cases, histopathological studies were possible in 20 cases. Among these, 9 cases were follicular adenomas, 2 were Hurthle cell adenomas, 5 follicular carcinomas, 2 showed features of nodular goiter, 1 showed features of Hashimoto′s thyroiditis, and the remaining 1 was histologically diagnosed as a follicular variant of papillary thyroid carcinoma (FVPTC).

Khan *et al* (2009) studied 81 cases of thyroid FNAC with histological evaluation in Pakistan; 5 were unsatisfactory and 76 were satisfactory for cytological evaluation. Cytohistological correlations were carried out for these cases. The study showed a diagnostic accuracy of 93% with sensitivity and specificity rates of 75% and 96% respectively, Positive predictive value of 81% and negative predictive value of 95%.

An Ethiopian study on FNAC showed a 96.9% accuracy for diagnosing simple goiter (Bekele, 2007). A study in Saudi Arabia reported FNAC sensitivity and specificity of thyroid of 71.4% and 96.4% respectively (Khairy & Murshid, 2004).

The diagnostic sensitivities and specificities reported in most studies, ranges widely from 50% to 100% and 64.6% to 100%. Factors that contributed to such a broad range are how pathologists handle the category of "suspicious" and follicular neoplasm's. Some pathologists included follicular neoplasms in the malignant/neoplastic category; others categorized them in the negative group, whereas others excluded them from the calculations. This study adopted the Bethesda system (Cibas & Ali, 2009) of categorizing thyroid masses where follicular neoplasm's are classified as suspicious for malignancy and are excluded from the accuracy analysis.

Based on the reviews above, it's clear that most of the studies were done outside Africa. Very few studies were done in Africa, only 2 in the Sub Saharan Africa hence the need was for more studies in other regions, especially the resource limited countries since FNAC is cheaper and non invasive The current study is based in MTRH, Eldoret Kenya and there is no local evidence on the accuracy of FNAC.

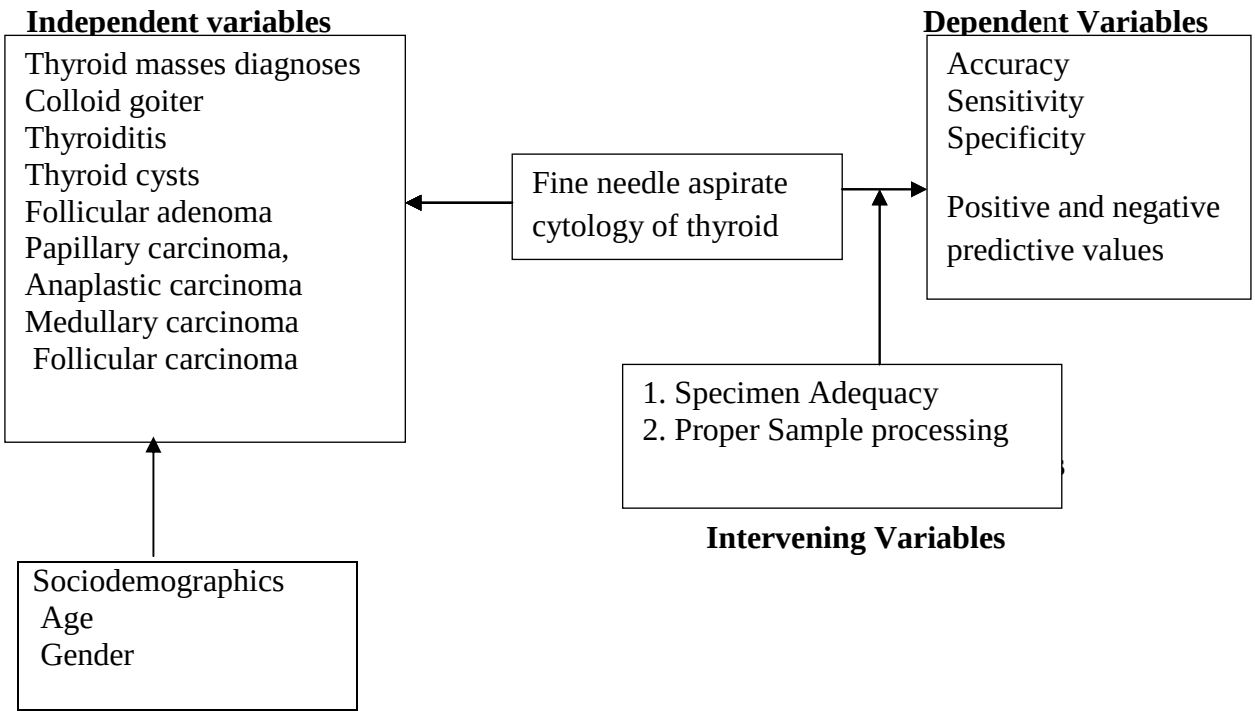

Figure 2.1 Conceptual framework

CHAPTER THREE: MATERIALS AND METHODS

3.1 Study Area

The study was conducted at Moi Teaching and Referral Hospital (MTRH) anatomic pathology in Eldoret, Uasin Gishu County located about 320 kilometers North West of Nairobi between latitudes 0° 31’ 54” N and longitude 35° 15' 58" E. This is the second Referral Hospital in Kenya serving Western Kenya region including the North and South Rift valley, Nyanza, Western Province, parts of Eastern Uganda and Southern Sudan.

Kenya is a developing Country located in Sub Saharan Africa, bordered by Tanzania, Somalia, Uganda, Sudan and Ethiopia. Thyroid disorders are endemic in some parts of Kenya, including the Western region where the soil, water and food supply contain little iodine.

3.2 Study Design

This was a retrospective comparative descriptive survey study in which FNAC reports and histological evaluation reports of patients who had FNAC diagnosis of thyroid and subsequently thyroidectomy for definitive histological diagnosis between January 2007 and December 2014 were reviewed. FNAC findings were then compared with the corresponding histological evaluation diagnosis for concordance and discrepancy.

3.3 Study Population

Fine needle aspirate cytology reports and subsequent histopathological reports of patients who had FNAC diagnosis of thyroid masses and subsequent thyroid surgery for histopathological evaluation for definitive diagnosis from January 2007 to December 2014 irrespective of their ages and genders.

3.4 Eligibility Criteria

3.4.1 Inclusion criteria

Fine needle aspirate cytology of thyroid reports whose corresponding histological diagnoses were available within the study period irrespective of patient's ages and gender.

3.4.2 Exclusion criteria

Fine needle aspirate cytology reports of thyroid whose histological evaluation findings were unavailable.

3.5 Data collection Procedure

A proforma was used to collect data; the proforma had provisions for participant's registration number, age, gender, cytology number, FNAC findings, histology number and histological evaluation findings. The cytology and histology reports of patients who had FNAC of thyroid and subsequently a thyroid surgery from January 2007 to December 2014 were accessed from the file copies in the archives of the anatomical pathology laboratory. The cytology and histology numbers in the respective registers were used to access and retrieve the FNAC and histological reports respectively.

The age, gender, FNAC findings and its corresponding histological diagnosis were entered in the proforma. FNAC diagnoses reports were classified into 4 categories; unsatisfactory for diagnosis, indeterminate (suspicious), benign and malignant. "Unsatisfactory" for diagnosis encompassed reports of smears with insufficient cellularity or poor quality due to delayed or improper fixation and aspirates consisting only of cyst fluids. The indeterminate (suspicious) category encompassed aspirates with atypical features suggestive of, but not diagnostic for malignancy and included follicular neoplasm's, cellular adenomatoid nodules, hurthle cell proliferations and lesions suspicious for papillary carcinomas. Smears classified as "benign"

were smears without atypical or malignant features and included colloid goiter, colloid or adenomatous nodules, thyroglossal duct cyst, Hashimoto's, sub-acute thyroiditis and other types of thyroiditis. The malignant category encompassed smears with cytological findings of primary or secondary malignancy and included papillary carcinoma, follicular carcinoma, medullary carcinoma and anaplastic carcinoma. Histological evaluations were categorized as either benign or malignant.

Fine needle aspirate cytology diagnoses were then compared with the gold standard histopathologic diagnoses. Fine needle aspirate cytology findings that were in agreement with those of corresponding histological evaluation were summarized as correlating. Fine needle aspirate cytology results that disagreed with the corresponding histological evaluation findings were summarized as discrepant. The discrepant findings were defined as either false negatives or false positives. False negatives were those cases in which FNAC failed to confirm malignancy while histopathology showed malignancy and false positives were those cases in which FNAC showed malignancy but histopathology showed no evidence of malignancy. The validity and reliability of the data collection tool was ensured by doing a test-retest of 10 FNAC and subsequent histological findings of the year 2010 and another 10 FNAC and subsequent histology findings of 2011. The correlation coefficient of the two sets of tests was 0.4 showing that there was a relationship between the two, thus the instrument is sufficiently reliable. The 2 years 2010 and 2011 were settled at because it's the midpoints of the study period.

3.6. Sampling Design

One hundred and sixty eight FNAC of thyroid reports and corresponding histological evaluation findings of reports which met the study criteria were reviewed and captured in a

random number generator. FNAC and corresponding histological evaluation findings of 118 participants were generated by simple random sampling technique.

3.7 Sample Size Determination

The sample size for this study at 95% confidence level was 118 FNAC and corresponding histological evaluation reports. This was arrived at this by adopting a mathematical model from Miller and Brewer.(Miller & Brewer, 2003). The model is expressed below

$$n = \frac{N}{1+N(\propto)^2}$$

Where; n is the required sample size

N is the sampling frame (number of FNAC diagnosis and subsequent thyroidectomy for histological evaluation within the study period and is at168)

$\propto$ Is confidence interval at 95% = 0.05.

On substitution,

$$n = \frac{168}{1+168(0.05*0.05)}$$

=118 participants.

3.8 Data Management and Analysis

The data of the generated samples were double checked and corded in SPSS version 20.0 for analysis. Contingency table analysis was done to determine the diagnostic accuracy of FNAC. Descriptive statistics was carried out for continuous variables (age) using mean and range. Frequency listings were done for categorical variables. Kappa statistics was done to measure whether there was significant agreement between FNAC of thyroid and the gold standard histological technique. Excel software was used to make pie charts and bar graphs.

P value of <0.05 was considered significant. The results were presented in tables, bar graphs and pie charts.

3.9 Ethical Considerations

Approval to carry out the study was sought from MTRH and Moi University Institutional Ethics and Review committee (IREC) via approval no 0001408. Confidentiality was maintained throughout the study period, names or any other form of identification were not indicated anywhere in the study tool. Codes (hospital numbers) were used to identify the participants. The completed data were kept under key and lock accessible only to the researcher and assistant researcher. Data entered into the computer was password protected.

3.10. Study Limitations

This was a retrospective review of 7 year data of FNAC findings and subsequent histological evaluation report findings of patients who had both tests done between January 2007 and December 2014. The reports were retrieved from the archives of MTRH hospital Pathology Laboratory. There was no data base and therefore filing of patient's reports was done manually, equally retrieval of the reports was also manually. From the respective patients register there were some cases that a particular patient had FNAC done and subsequently a thyroid resection for histology and when it comes to the copy of results in the file, the results of one test could be missing. This resulted to longer time taken in reviewing the data and other patient's results were unavailable due to misfiling and were left out of the study meaning that the sample size achieved would have been bigger than what was studied.

CHAPTER FOUR: RESULTS

4.1. Introduction

118 participants who met the study criteria within the study period were recruited into the study.

4.2 Cytological Patterns of Thyroid Masses

FNAC diagnoses were categorized into 4 categories; inadequate to make a diagnosis, suspicious for malignancy, non neoplastic and neoplastic. The 118 FNAC yielded 17 cases (14.4%) as inadequate to make a diagnosis, 14 (11.9%) cases suspicious for malignancy, 78 (70.27%) non neoplastic cases and9 (7.6%) neoplastic cases. The non neoplastic cases consisted predominantly of colloid goiter at 62 (52.5%), thyroiditis at 12 (10.2%) and 4thyroid cysts (3.4%). The neoplastic lesions consisted of 6 papillary carcinomas (5.1%) and 3 (2.5%) medullary carcinomas.

Table 4.1: Summary of FNAC diagnoses (n=118)

FNAC category	Frequency	(%)
(Inadequate**)**	17	(14.4)
(Suspicious**)**	14	(11.9)
(Non neoplastic n=78**)**		
Colloid goiter	62	(52.5)
Thyroiditis	12	(10.2)
Thyroid cysts	4	(3.4)
(Neoplastic n=9**)**		
Papillary carcinoma	6	(5.1)
Medullary carcinoma	3	(2.5)

4.3 Age and Gender Distribution of Thyroid Pathologies

There were 88 females and 30 males, accounting for 74.6% and 25.4% of the study populations respectively. This was a male: female ratio of 1:3.The ages of the patients were between 17-88 years with a mean of 40.61, standard deviation of +14.93, a median of 37.50, a mode of 28 years and a range of 71. The youngest participant was 17 years diagnosed with colloid goiter and the oldest was 88 years diagnosed with papillary carcinoma. The mean age of Male participants was 49.7; the mean age of the females was 37.51.

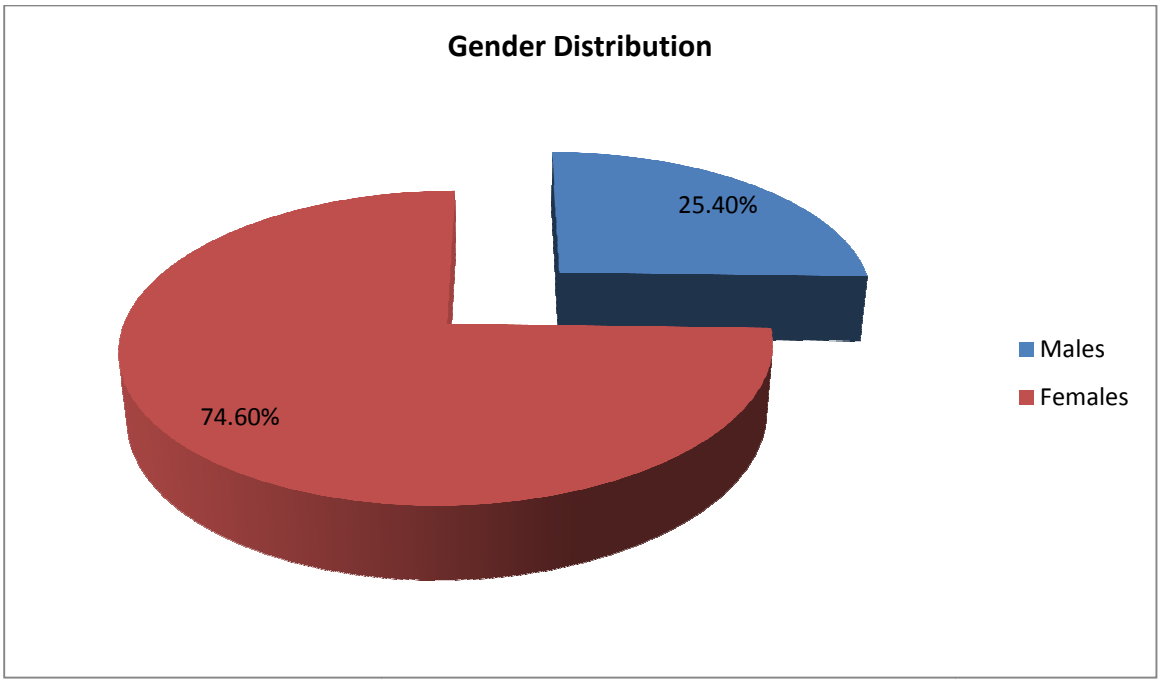

Figure 4.1: Gender distribution

The youngest and old participants were both females. Malignancy was diagnosed in 11 participants; 4 males and 7 females. The mean age of males with malignancy was 52.25 while that of females was 43.57. The youngest female diagnosed with malignancy was aged 20 years while the youngest male was aged 27 years. Out of the 7 females diagnosed with malignancy, 4 were aged below 40years

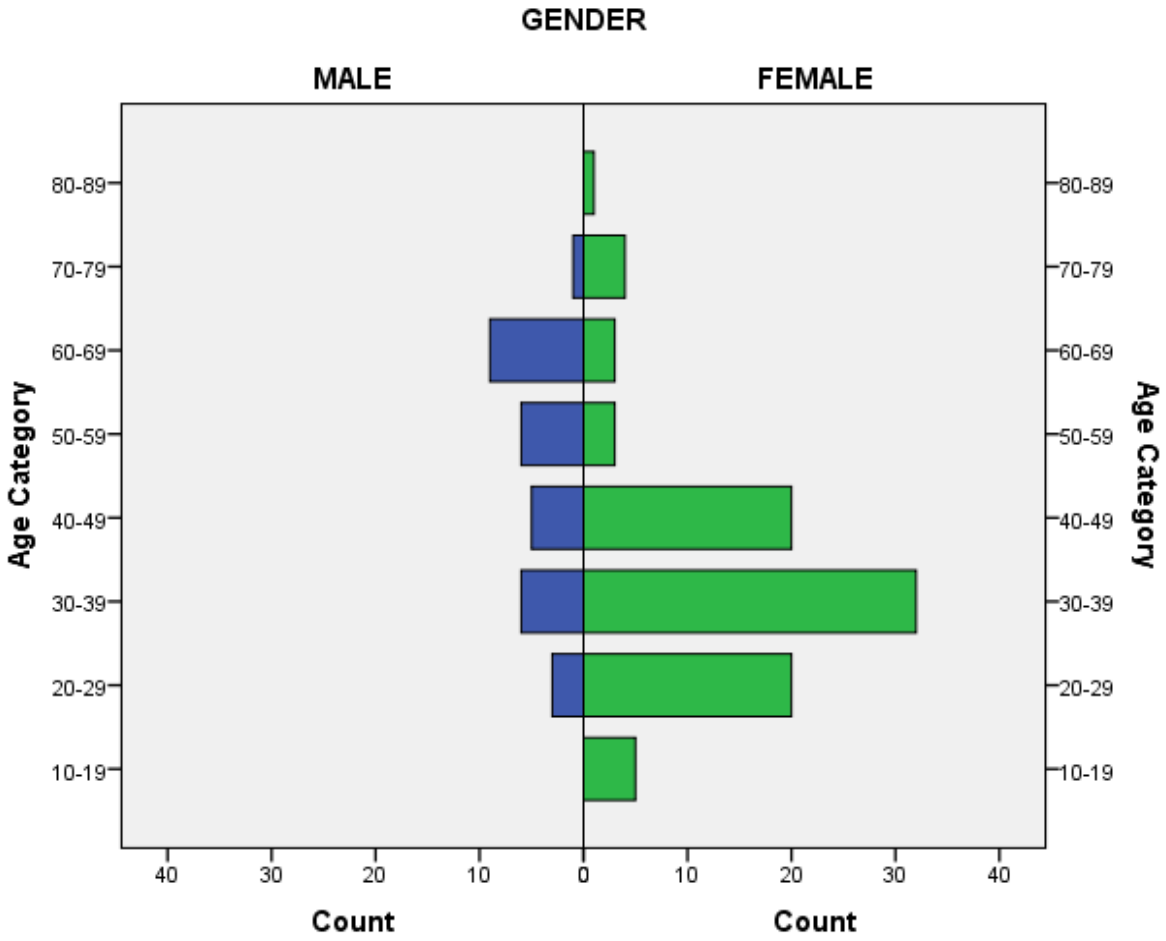

Figure 4.2: Age and gender distributions of patients

4.4 Correlation of FNAC Diagnoses with those of Corresponding Histological diagnoses

FNAC diagnostic categories were compared with the corresponding gold standard histopathological diagnosis. The 17 inadequate FNAC diagnoses were histologically diagnosed as; 7 thyroid cysts, 6 colloid goiters, 1 follicular adenoma, 1 thyroiditis 1 follicular carcinoma and 1 anaplastic carcinoma. The 14 suspicious FNAC cases on histological evaluation revealed 1 colloid goiter and 13 follicular neoplasms (11 follicular adenomas and 2 follicular carcinomas). On the non neoplastic category; the 62 colloid goiter diagnoses on FNAC, 57 correlated with histological diagnoses and 5 cases were discrepant; the discrepant cases histologically turned out to be 2 papillary carcinomas, 1 medullary carcinoma and 2

follicullar adenomas. Of the 4 thyroid cysts on FNAC 3 correlated with final histological diagnoses, 1 was discrepant and was diagnosed histologically as medullary carcinoma. Of the 12 cases of thyroiditis, 10 correlated with the histological diagnosis whereas 2 were discrepant and histologically turned out to be follicular neoplasm's (1 follicular carcinoma and 1 follicular adenoma).

The neoplastic FNAC category diagnoses were 6 papillary carcinomas and 3 medullary carcinomas. When correlated with the final histology evaluation findings, 4 papillary carcinomas correlated and 2 were discrepant. The discrepant ones turned out to be 1 colloid goiter and 1 thyroiditis. On the 3 medullary carcinomas, 2 correlated with histological evaluation diagnoses while 1 was histologically diagnosed as thyroiditis.

Out of the 78 non neoplastic FNAC diagnoses, 70 cases correlated with corresponding histological evaluation diagnoses whereas 8 (5 neoplastic and 3 non neoplastic) were discrepant. Of the 9 neoplastic FNAC diagnoses, 6 correlated with corresponding histological diagnoses and 3 were discrepant. The 3 discrepant were non neoplastic on histology (2 thyroiditis and 1 colloid goiter). Generally 79 cases correlated (6 true positives and 73 true negatives) and 8 were discrepant (3 false positives and 5 false negatives), translating to a concordance and discordance rate of 87.40% and 12.60% respectively.

Table 4.2: Correlation of FNAC findings with corresponding histological findings

FNAC
Diagnosis **Gold standard histological evaluation diagnoses**

	Colloid goiter	Follicular Adenomas	Thyroiditis	Thyroid cysts	Papillary carcinoma	Follicular carcinoma	Medullary carcinoma	Anaplastic carcinoma
Inadequate **n=17**	6	1	1	7	-	1	-	1
Suspicious **n = 14**	1	11	0	-	0	2	-	-
Colloid goiter **n=62**	57	2	-	-	2	-	1	-
Thyroid cyst **n=4**	-	-	-	3	-	-	-	1
Thyroiditis **n=12**	-	1	10	-	-	1	-	-
Papillary carcinoma **n =6**	1	-	1	-	4	-	-	-
Medullary carcinoma **n= 3**	-	-	1	-	-	-	2	-

4.4.1 The accuracy of FNAC

Upon comparing FNAC diagnoses with the corresponding histological evaluation diagnoses for correlations and discrepancies, the study yielded 79 FNAC diagnoses that correlated with the corresponding histological evaluation diagnoses(73 true negatives and 6 true positives) and 8 FNAC diagnoses that were discrepant with the corresponding histological evaluation diagnoses (3 false positives and 5 false negatives). In general, there were 73 true negatives, 6 true positives, 5 false negatives and 3 false positives. The suspicious and inadequate FNAC diagnoses were excluded from the statistical analysis owing to its non diagnostic importance.

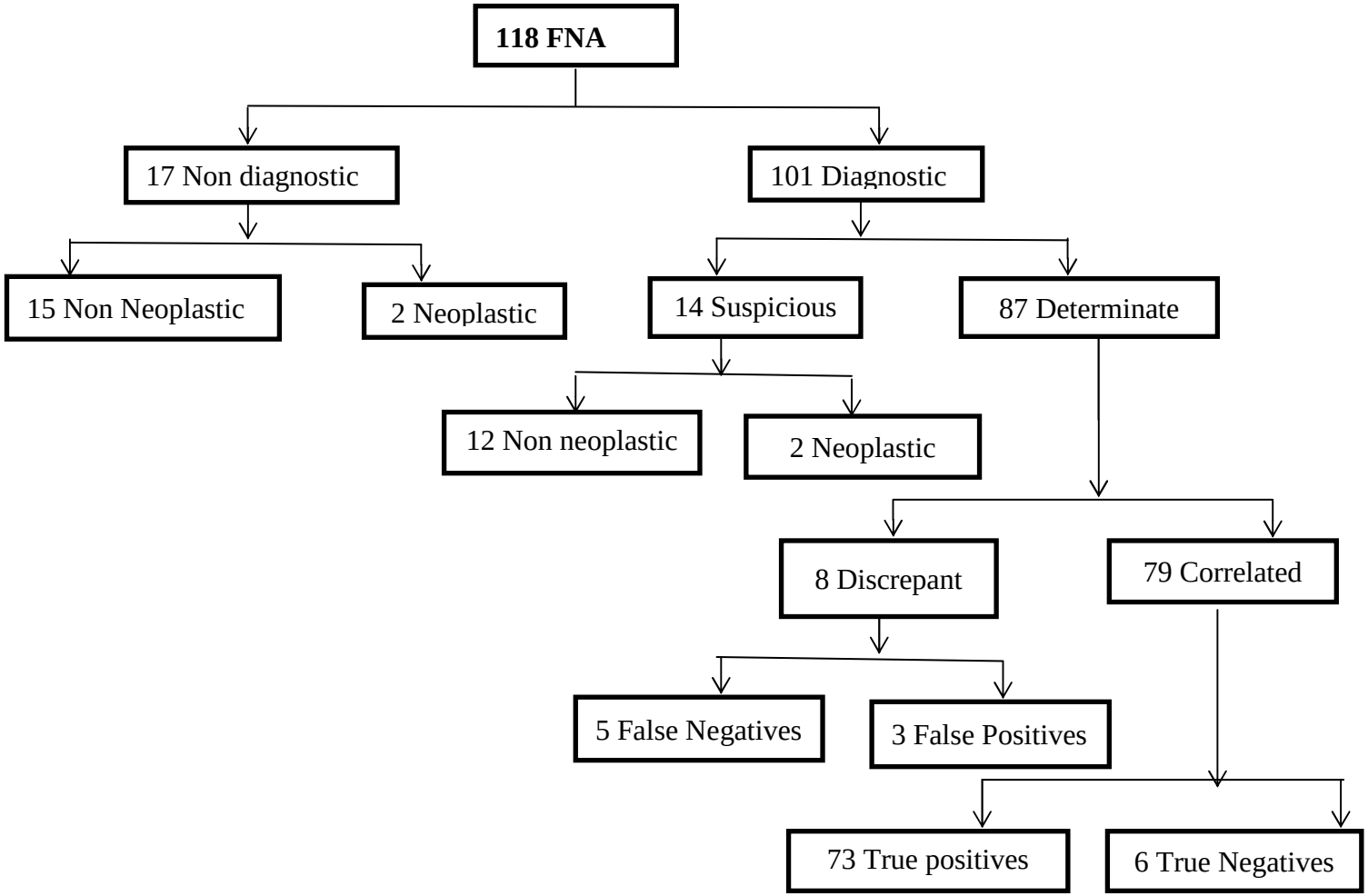

Figure 4.3 Cytohistological confirmation of suspected thyroid masses from FNA samples.

From figure 3 above, contingency table was done to analyze the diagnostic accuracy of FNAC. Kappa statistics was also done to establish whether there was significant agreement and association between FNAC of thyroid and histological evaluation.

Table 4.3: Contingency table for accuracy

	Histological diagnosis		
Test (FNAC)	Disease +ve	Disease –ve Totals	
Disease +ve	A(6) TP	B(3) 9 FP	
Disease -ve	C(5) FN	D(73) 78 TN	
Totals	**11**	**76**	**87**

Sensitivity= TP/ TP+FN × 100
=6/I1×100 = 54.54%

Specificity= TN/TN+FP × 100
=73/76 × 100 = 96.05%

Positive predictive value = TP/TP+FP ×100
= 6/9 × 100 = 66.66%

Negative predictive value = TN/TN+FN ×100
= 73/78 × 100 = 93.58%

Accuracy = TP+TN/Total No ×100
=79/87 × 100 = 90.80%

Basing on the above contingency table, kappa statistics was run to show the agreement between FNAC and histological evaluation in diagnosing thyroid masses. The kappa statistic of agreement had a chi- square distribution with 1 df under the null hypothesis (Ho: the test procedures, FNAC and histological evaluation of thyroid are independent (do not agree). The associated p-value was 0.34.

CHAPTER FIVE: DISCUSSION

5.1 Introduction

Fine-needle aspiration cytology of thyroid is simple, minimally invasive, cost effective, readily available and reliable, time saving and an easy to perform outpatient procedure (Caruso P, 1991). Due to its simplicity, low cost and absence of major complications, it is being performed on an increasing number of patients, which has led to detection of thyroid cancer at earlier stages, resulting to better outcome of patients (Tyler *et al*., 2000).

5.2 Age and Gender Distribution

As reported in the earlier literature, age and gender are associated factors of thyroid lesions (Vander *et al*., 1968). In the current study there were 88 females (74.6%) and 30 males (25.4%), this was a female predominance giving a male female ratio of 1:3. This could be due to the fact that thyroid nodules are more common in women (Vander *et al.*, 1968). The male female ratio is comparable to those of other studies; Wahid *et al* (2011) reported 57 females and 25 males, with female: male ratio of 2.28: 1. Sinna and Ezzat reported a female to male ratio of 5.2:1(Sinna & Ezzat, 2012).

The ages of patients in the current study ranged from17 to 88 years with a mean of 40.61 and SD of +14.93. The mean age of male patients was greater than that of female patients; 49.7 and 37.51 respectively. Wahid *et al* reported an age range of 16-65 years, with mean age of 42.56 S.D +11.60 years (Wahid *et al.*, 2011). Muratli *et al* reported age range of 17-89 years and a mean of 51.24 (Muratli *et al*., 2014). The age range is comparable to that of a study by Muratli *et al*. The mean ages of the patients are similar to that of Wahid *et al.* In the current study, we found that most of the

patients were in their 3rd decade. This is comparable to that of a study by Bamanikar (Bamanikar *et al*., 2014) who reported that most patients were aged between 30 and 40 years.

5.3 Cytological Patterns of Thyroid Masses

On the cytological patterns of thyroid masses, Esmaili and Taghipour reported 9.2% unsatisfactory, 64.3% benign, 7.8% malignant and 18.66% suspicious. (Esmaili & Taghipour, 2012). In the current study, the unsatisfactory rate is at 13.6%, benign 65.3%, malignant 8.6% and 12.7% suspicious. This is comparable with previous studies that have reported inadequacy rate of 0 to 25% (Gharib & Goellner, 1993; Shenovi *et al.*, 1995). Bhatta *et al* (2012) reported colloid goiter as the commonest benign thyroid mass and papillary carcinoma as the commonest malignant thyroid lesion (Bhatta *et al.*, 2012). In this current study, the commonest benign thyroid lesion was colloid goiter which is in keeping with the findings of a study by Bhatta and wahid.

5.4 Accuracy of Fine Needle Aspiration Cytology of Thyroid

On cytohistologic correlations in this study, 17 (14.4%) FNAC were unsatisfactory to make a diagnosis. This is in agreement with previous studies that have shown inadequacy rate of between 0 to 25% (Gharib & Goellner, 1993; Shenovi *et al*., 1995). Alta Villa *et al* (1990) reported an inadequacy rate of 16.11%; this is slightly higher than for the current study (14.4). This can be explained on the basis that Alta Villa *et al* examined a larger population than the current study. Inadequate FNAC in this study could have resulted from sampling error, aspiration of sclerotic or calcified lesions and also nodules with large areas of cystic degeneration or necrosis. Sampling

errors could have been mitigated with the use of ultrasound scan to help locate the nodule and guide aspiration. Thyroid ultrasonography gives details about the characteristics of the nodule and its potential risk of malignancy (Mehanna *et al*., 2009)

The current study reported 14 (11.9%) suspicious FNAC cases. This is comparable to that of a study by Sinna and Ezzat (2012) which reported 10.1 % suspicious FNAC. However the suspicious FNAC in this study is higher than that reported by Kumar *et al* (2014) which reported 4 suspicious cases. This may be explained on the basis that Kumar *et al* used ultrasound imaging to guide FNAC procedure and this improved the specimen adequacy. The suspicious cases in the current study may be attributed to overlapping cytological features between some benign and malignant thyroid lesions especially in the cases of follicular neoplasm's where the differentiation between follicular carcinoma and follicular adenoma is based on the evaluation of the capsule. In FNAC, it's difficult to aspirate the capsule which is very crucial in thyroid diagnosis.

Seventy nine FNAC diagnoses correlated with the corresponding histological evaluation diagnoses (70 true negatives and 6 true positives) whereas 8 FNAC diagnoses were discrepant with the corresponding histological evaluation diagnoses (3 false positives and 5 false negatives). In general, there were 73 true negatives, 6 true positives, 5 false negatives and 3 false positives translating to a concordance rate of 90.80%, false negative rate of 5.74% and a false positive rate of 3.44%. Gharib reported a false negative rate of 1% to 11%, a false positive rate of 1% to 8% (Gharib & Goellner, 1993**).** Pandey *et al* (2012) reported cytohistological concordance of

80.28% and discordance of 19.72%. Of the discordant cases, false positives accounted for 11.60% and false negatives for 8.12%. Bhatta *et al* (2012) reported a false negative rate of 14.28% and false positive rate of 7.69%. In the current study, the concordance rate, false positive rate and false negative rates were 90.80%, 3.44% and 5.74% respectively. The concordance rate of the current study is higher than that reported in a study by Pandey *et al* (80.28%). This can be explained on the basis that the population studied by Pandey is so small (54), which is smaller by more than a half of the current study (118). The false negative and false positive rates are within the ranges reported by Gharib (1993).

The diagnostic sensitivities and specificities reported above, range widely from 50% to 100% and 64.6% and 100%. Factors that contributed to such a broad range are how pathologists handle the category of "suspicious" and how they defined the false-positive and false-negative results. Some pathologists included follicular neoplasms in the malignant/neoplastic category; others categorized them in the negative group, whereas others excluded them from the calculations.

In the current study, the sensitivity, specificity, PPV, NPP and accuracy of FNAC was 54.54%, 96.05%, 66.66%, 93.58% and 90.80% respectively. Gulia *et al* (2011) reported sensitivity, specificity, PPV, NPV and accuracy of 100%, 90.0%, 100%, 90.5% and 92.3% respectively. The sensitivity reported by Gulia *et al* is high compared to that of the current study. This can be justified by the fact that FNAC in the study by Gulia was done under the guidance of Ultrasound thereby improving the quality and yield of FNAC smears. Bhatta *et al* (2012) reported a sensitivity, specificity, PPV, NPV and accuracy of 85.7 %,92.3 %,92.31%, 85.72% and 90 %

respectively. Pandey *et al* (2012) reported sensitivity, specificity, PPV, NPV and accuracy of 57.14%, 90%, 70.58%, 83.33% and 80.28% respectively. Muratli *et al* (2014) reported sensitivity, specificity, PPV, NPV and accuracy of 87.1%, 64.6%, 76.1%, 79.5% and 77.3% respectively. Mahar *et al* (2005) reported sensitivity, specificity, PPV, NPV and accuracy of 98%, 70%, 91%, 93% and 91% respectively. The sensitivity and specificity reported by Mahar is far much higher than what was reported by the current study, this is because Mahar *et al* categorized follicular neoplasms in the non neoplastic category whereas the current study excluded them Bamanikar *et al* reported a sensitivity of 50%, in our study the sensitivity is 54% which is comparable. The study populations by Bamanikar and the current study are also comparable.

The Kappa statistical analysis for agreement showed a significant agreement between FNAC of thyroid and histological evaluation technique with associated p-value of 0.34. This observation gives credence to rejection of the null hypothesis (the two test procedures are independent) at 5% level of significance. Thus the current study concludes that the two tests (FNAC and histological evaluation) have a significant level of overall agreement.

CHAPTER SIX: SUMMARY OF THE FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of Findings

Fine needle aspirate cytology reports and corresponding histological evaluation findings of 118 participants were sampled and studied. Cytology yielded 17 (14.4%) inadequate for diagnosis, 14 (11.9%) suspicious for malignancy, 78 (70.27%) non neoplastic and9 (7.6%) neoplastic cases. the non nseoplastic FNAC category consisted predominantly of colloid goiter whereas the neoplastic category consisted of papillary carcinoma.

There were 88 females and 30 males, accounting for 74.6% and 25.4% of the study populations respectively. This was a male: female ratio of 1:3.The ages of the participants ranged between 17-88 years with a mean of 40.61, standard deviation of +14.93, a median of 37. Most of the participants were in their third decade.

When compared with the subsequent findings of gold standard technique, 79 FNAC diagnoses correlated (70 true negatives and 6 true positives) whereas 8 FNAC diagnoses were (3 false positives and 5 false negatives). In general, there were 73 true negatives, 6 true positives, 5 false negatives and 3 false positives translating to a sensitivity, specificity, PPV, NPP and accuracy of 54.54%, 96.05%, and 66.66%, 93.58% and 90.80% respectively. The findings of this study are comparable to those of other studies cited in the literature.

There was significant agreement between FNAC of thyroid and histological technique

6.2 Conclusions

i. The majority of thyroid masses are benign, only small proportions are malignant

ii. Thyroid pathologies are more common in females than in males and the risk of malignancy increases with age.

iii. FNAC of thyroid is accurate; it has a low rate of false-negative and false-positive diagnoses

6.3 Recommendations

i. Fine needle aspiration cytology to be done under the guidance of Ultrasound so as to improve cellular yield thus reducing the rate of suspicious and unsatisfactory cases.

ii. Though thyroid masses are more common in females than in males and increased malignancy is associated with male gender and females with ages less than 15 and greater than 45 years, caution should be exercised while dealing with thyroid pathologies irrespective of patient's age and gender; as in the current study, 4 females aged between 20-40 years had malignancy.

iii. FNAC of thyroid can be adopted and relied upon in the evaluating thyroid nodules, thus reducing the rate of thyroidectomies in benign pathologies.

6.4 Suggestions for Further Research

Similar prospective studies to be carried out under the guidance of Ultrasound imaging to establish the cause of the false negatives and false positives.

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APPENDICES

APPENDIX I: DATA COLLECTION PROFORMA

THE DIAGNOSTIC ACCURACY OF FINE NEEDLE ASPIRATION CYTOLOGY IN EVALUATING THYROID MASSES AT MOI TEACHING AND REFERRAL HOSPITAL.

Study number …….. Patient's id …… Date …….

Tick the appropriate box

Gender Male ☐ Female ☐ Age of the patient in years ☐

FNAC details;
Cytology number……. Date of FNAC……

Suspicious ☐

Unsatisfactory ☐

Benign diagnoses

Colloid goiter ☐

Thyroiditis ☐

Follicular adenoma ☐

Thyroid cysts ☐

Malignant diagnoses;

Papillary carcinoma, ☐

Follicular carcinoma, ☐

Medullary carcinoma ☐

Anaplastic carcinoma ☐

Histological evaluation details
Histology number……..Date of histology……

Benign diagnoses;

Colloid goiter ☐

Thyroiditis ☐

Follicular adenoma ☐

Thyroid cysts ☐

Malignant diagnoses;
Papillary carcinoma ☐

Follicular carcinoma ☐

Medullary carcinoma ☐

Anaplastic carcinoma ☐

Comparison between FNAC and Histological findings
Correlates ☐

Discrepant ☐

Correlates; True positive ☐

True negative ☐

Discrepant; False positive ☐

False Negative ☐

APPENDIX II: FORMAL APPROVAL

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET

Reference: IREC/2015/05
Approval Number: 0001408

18th May, 2015

Kiptanui Chebii,
Moi University,
School of Medicine,
P.O. Box 03-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
18 MAY 2015
APPROVED
P.O. Box 4606-30100 ELDORET

Dear Mr. Chebii,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

"Utilizing Fine Needle Aspiration Cytology in Evaluating Thyroid Masses at Moi Teaching and Referral Hospital Eldoret."

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 1408*** on 18th May, 2015. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 17th May, 2016. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

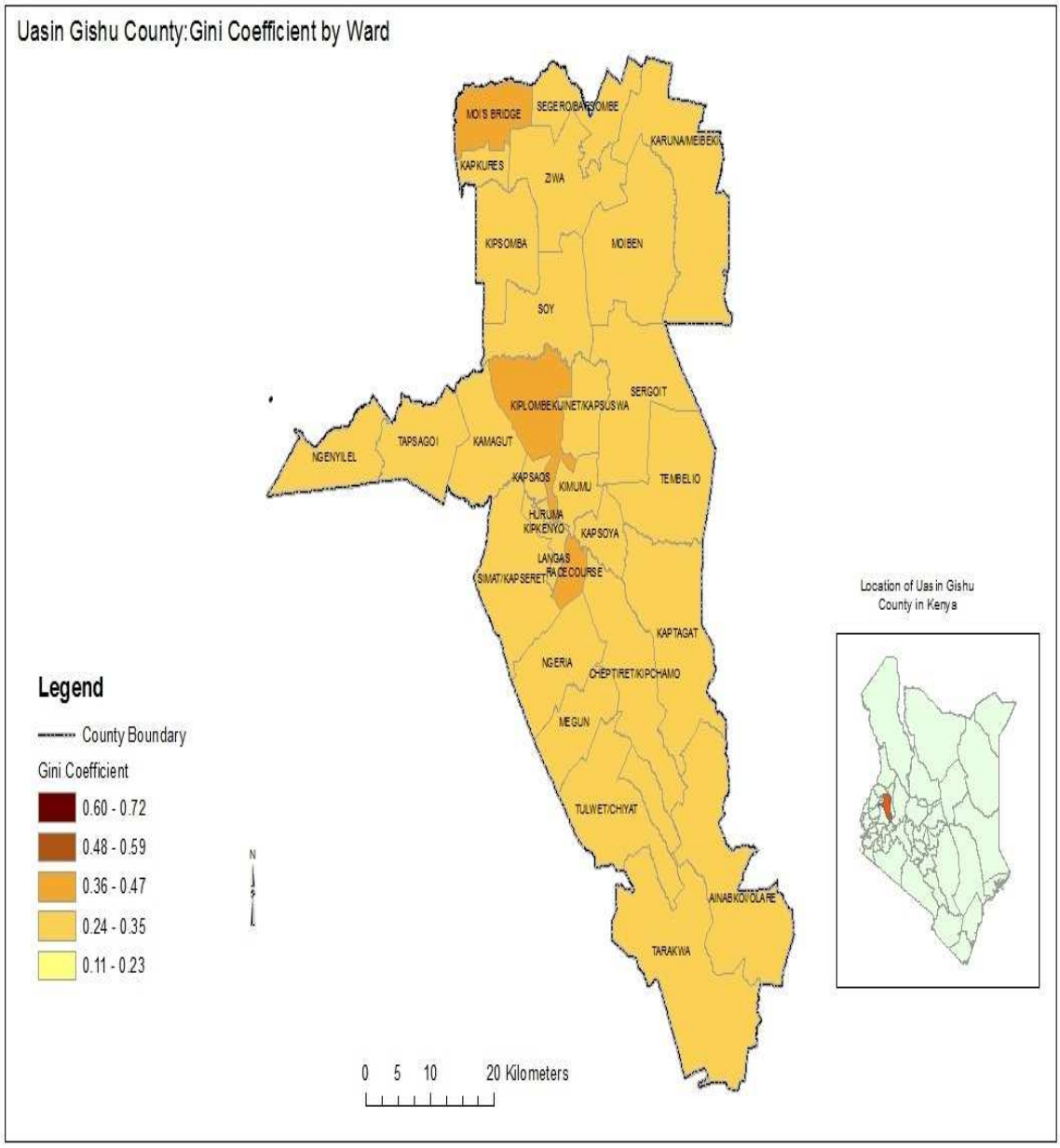
You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc Director - MTRH Dean - SOP Dean - SOM
Principal - CHS Dean - SON Dean - SOD

APPENDIX III: MAP OF UASIN GISHU COUNTY



APPENDIX IV: FINE NEEDLE ASPIRATION CYTOLOGY PROCEDURE

The technique is basic and involves;

i. Placing the patient in a supine position with a small pillow under the shoulders and upper back with the neck posteriorly extended
ii. Under aseptic technique, localize the nodule between the fingers. The use of local anesthesia remains optional.
iii. A 21 or 23 gauge needle attached to a 10 ml syringe is introduced into the thyroid nodule and then the passes are repeated several times while rotating the needle between the finger and thumb.
iv. Aspiration using the 10 ml syringe is done and terminated when material is visible in the hub of the syringe.
v. The contents of the syringe are sprayed onto a glass slide, thinly spread out and either air dried or fixed in alcohol.
vi. The dried or alcohol fixed specimen on the glass slide are stained with May-Grunwald Giemsa

Staining procedure for May-Grunwald Giemsa

1. Fix the air-dried smear specimen in methanol for 10 -20 minutes
2. Stain with May-Grunwald working solution for 5 minutes
3. Stain with Giemsa working solution for 12 minutes
4. Wash with clean buffered water for 2, 5 and 2 minutes
5. Dry the slides in upright position at room temperature
6. Mount the slides with a cover slip using DPX