



## Original Research Article

## Study of diagnostic accuracy of non-aspiration cytology in solid tumors

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## ABSTRACT

**Introduction:** Fine needle aspiration cytology (FNAC) is widely accepted as a primary method for the diagnosis of thyroid lesions. An alternative to FNAC is fine-needle sampling without aspiration (FNNAC). FNAC is easy to perform, quickly and has a high degree of sensitivity and specificity and avoid unnecessary surgery. Hence the present study was performed to study the diagnostic accuracy of FNNAC with FNAC technique in solid tumors.

**Materials and Methods:** An observational study was carried out on 325 patients with swellings in the breast, thyroid, and soft tissues and enlarged lymph nodes in the Department of surgical oncology, Regional Cancer Centre, Government Coimbatore Medical college hospital, Coimbatore, India. A single pathologist was responsible for all cytological and histological reports. Slides of both approaches were analysed and compared using Mair et al grading methodology, which depends on five factors. The number of smears with superior quality and diagnostic accuracy is compared and analysed statistically using the 'z' test for two proportions.

**Results:** FNNAC produced better smears with less haemorrhage in vascular organs like the thyroid. FNAC performed better in breast fibrous lesions such as fibroadenoma and phyllodes tumour. For malignant lumps of breast and lymph nodes, FNAC yields better material than FNNAC.

**Conclusion:** The current research shows that FNNAC is the superior approach for highly vascular organs such as the thyroid because it yields high-quality smears with less blood admixtures. Although FNAC smears were more often diagnostic, they typically yielded acceptable rather than excellent grade smears.

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## 1. Introduction

Thyroid gland enlargement is widespread in most regions of the globe, particularly in iodine-deficient goitre belt areas, where the frequency may be as high as 40%.<sup>1</sup> Both the patient and the practitioner are concerned when a goitre develops since the swelling might be cancerous. The majority of goitres are benign, and malignancy is discovered in only around 10% of solitary nodules chosen for surgery or clinical reasons. Thyroid cancer incidence almost quadrupled between 1975 and 2009, owing to an

increase in papillary thyroid carcinoma. Therefore, early detection and treatment have become very important in curing malignant thyroid carcinoma.<sup>1</sup>

Fine needle cytology has recently got famous among clinicians and pathologists. FNAC and FNNAC are two techniques of fine needle cytology. FNAC is simple to use, fast to execute and provides a high level of sensitivity and specificity. It helps to avoid unnecessary surgery.<sup>2</sup> FNNAC was developed in France in 1982 by Briffod et al.<sup>3</sup> In their study, they performed the investigation with 22 – 25 Gauze fine needle.<sup>4</sup> In the procedure, difficulties were reported either due to low negative pressures, which resulted

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in inadequate specimens or high negative pressures which resulted in hemorrhagic smear.

A modification of this technique termed FNNAC was introduced in France in 1982.<sup>5</sup> It does not use a syringe and instead relies on the physical characteristic of capillary pressure to suck cells into the needle hole.<sup>6</sup> FNNAC avoids active aspiration and relies on capillary tension to suck the tissue sample into the needle bore; this reduces bleeding and minimizes trauma to thyroid tissue.<sup>3,7</sup> FNNAC seemed to be better for identifying malignant lesions, whereas FNAC appeared to be better for detecting benign lesions.<sup>8</sup> Many studies concluded that FNNAC provides better patient compliance, gave better cellular yields and it improves the quality of the material.<sup>9–12</sup> The studies have shown that the sensitivity of the two techniques was dependent on whether the tumour was vascular or necrotic and on other factors like fibrosis, and desmoplasia.<sup>11</sup> In thyroid neoplasms, better results were seen with FNNAC.<sup>7,13,14</sup>

Hence the present study aimed to assess and compare the diagnostic accuracy of the two techniques in various solid tumours and aims to suggest which technique will yield good quality material and minimal diagnostic failures.

## 2. Materials and Methods

This was an observational study performed in the *Department of surgical oncology, Regional Cancer Center, Government Coimbatore Medical college hospital, Coimbatore, India*, for 2 years from August 2017 to August 2019, comparing FNAC and FNNAC on 325 patients with lumps of the breast, thyroid, other soft tissues and enlarged lymph nodes. Only one investigator was responsible to prepare all smears to prevent person to person errors. The pathologist was not aware of the technique utilized. A single pathologist was responsible for all cytological and histological reports. In 153 cases, a histopathological report was provided.

The inclusion criteria consist of all patients above the age of 15 years with superficial solid tumours more than 1 cm size like –breast lump, swelling in the thyroid, parotid, soft tissue tumours and enlarged lymph node. Patients who had already had surgery received prior irradiation, or who had a large infection or cystic lesion were eliminated.

### 2.1. FNAC

*Procedure:* Alcohol was used to wash the skin above the swelling. A 5 mL plastic syringe with a 23 Gauge needle attached is held in the right hand. Two fingers of the left hand gripped the lump firmly. The needle was placed into the lump via the skin. The syringe was then used to suction the lump as the needle was pushed back and forth in the lump numerous times until the aspirate appeared in the needle's hub. This manoeuvre assisted in dislodging cellular

materials and allowed for simple suction into the needle, which was then released, and the needle was withdrawn and removed from the syringe.

### 2.2. FNNAC

*Procedure:* This approach did not need the use of suction. The right hand gripped the hub of the needle without the syringe in a pencil grip, and the needle was gently pushed into the lump and then moved in and out many times. The aspirate flowed into the needle by capillary action, and the needle was removed as soon as the aspirate appeared in the hub.

### 2.3. Preparation of smears

Air-filled syringe used to expel the aspirated material onto glass slide taking care to avoid splashing. The smears were made by applying mild pressure to a second glass slide to obtain thin, even spreads without crush artefacts. Smears were air-dried and stained using hematoxylin and eosin stain.

In this study both the techniques were compared to evaluate the efficacy and identify the most suitable method for neoplasms of breast, thyroid, lymph node and other solid tumours based on five objective parameters namely background blood, cellularity, the extent of cellular trauma, retention of architecture and degeneration. Smears were scored properly as per Mair et al. 1989, scoring system<sup>12</sup> (Table 1). Each of these criteria was given a score ranging from 0 to 2. Each FNAC and FNNAC specimen received a total score of 0-10 points, which was then given to one of three groups depending on the total points achieved given below.

Category	Score
Non-suitable for cytodiagnosis	0 – 2
Diagnostically adequate	3 – 6
Diagnostically superiority	7 – 10

The total numbers of superior-quality smears and the diagnostic accuracy are compared and analysed statistically using tests for two proportions - the 'z' test. The sensitivity and specificity of cytological examination were also evaluated by comparing it with histopathological examination report. Table 1

## 3. Results

In this study patients had age group ranging from 16 to 82 (Table 2) (mean = 51.5, median= 50, mode=50). There was 219 females (67.4%) and 106 males (32.6%) out of 325 patients. Among these majority (n=135) had breast lumps and 86 had head and neck lumps.

Out of 325 aspirates 87.69% (n=285) yielded satisfactory smears (superior or adequate) by FNAC and 83.6 % (n=272)

**Table 1:** Mairet al scoring system

Criteria	Qualitative Description	Score
Background blood & clot	Large amount – diagnosis not possible	0
	Moderate amount-diagnosis possible	1
	Minimal-diagnosis easy	2
Cellularity Amount of material	Minimal – diagnosis not possible	0
	Sufficient -diagnosis possible	1
	Adequate -diagnosis easy	2
Degree of cellular degeneration	Marked – diagnosis not possible	0
	Moderate -diagnosis possible	1
	Minimal-diagnosis easy	2
Degree of cellular trauma	Marked – diagnosis not possible	0
	Moderate -diagnosis possible	1
	Minimal-diagnosis easy	2
Retention of appropriate architecture	Minimal – diagnosis not possible	0
	Moderate -diagnosis possible	1
	Marked-diagnosis easy	2
	Total score	0-10

by FNNAC (Tables 2 and 3). The rest were unsatisfactory which consisted of excess blood in the smear and/or scanty aspirate material.

### 3.1. Breast lump

Out of 116 smears sampled from breast lumps, 95 were ductal carcinoma, 3 were fibroadenoma, 11 were fibrocystic disease and 1 was phyllodes tumour (Table 4). With FNAC, the number of diagnostically superior grade smears increased while the number of inappropriate smears decreased. FNAC yielded more satisfactory smears than FNNAC (105 vs 100) with an accuracy of 92.59% by FNAC and 88.88% by FNNAC (Table 5).

### 3.2. Thyroid

Out of 37 aspirates from thyroid swelling, smears were more satisfactory with FNNAC than FNAC (30 vs 24) with an accuracy of 73.68% by FNAC and 89.47% by FNNAC. The number of diagnostically superior smears was found to be higher with FNNAC (Table 6).

### 3.3. Lymph nodes

Out of 155 smears, 88 were metastatic deposits and 67 were reactive lymphadenitis and more satisfactory smears were seen with FNAC than FNNAC (143 vs 131) with the accuracy of 93.02% by FNAC and 86.04% by FNNAC (Table 7).

### 3.4. Other solid tumours

Out of 17 aspirates from other solid tumours which includes subcutaneous and muscular as well as salivary gland tumours, more satisfactory smears with FNAC than FNNAC

(13 vs 11) with the accuracy of 90% by FNAC and 70% by FNNAC (Table 8).

### 3.5. Statistical analysis of all solid tumours

For all tumours, the cytopathological examination is performed to determine sensitivity, specificity, diagnostic accuracy, and positive and negative predictive values which showed better results with FNAC than FNNAC in breast, lymph node and other solid lesions. In thyroid lesions, FNNAC scored better than FNAC (Table 9).

Out of 325 smears, 116 were from breast, 155 from lymph node, 37 from thyroid and 17 from other solid lesions (Table 10). The overall diagnostic accuracy of FNAC & FNNAC was 90.19% and 86.92% respectively (Tables 11 and 12).

It was found that the diagnostic accuracy was more with FNAC than FNNAC in breast, lymph node and other soft tissue lesions whereas FNNAC achieved a higher score in thyroid lesion in diagnostic accuracy (Tables 10 and 11).

Post-procedure complications: Pain was the most common complaint after the procedure. 11% of cases (n=36) complained of significant pain while the rest experienced only mild to no pain. There was no incidence of nerve or vascular injury through the procedure.

## 4. Discussion

Fine needle sampling is a common diagnostic procedure for a variety of clinical diseases. Fine needle aspiration cytology is based on the aspiration of cellular material from target masses, which is generally done with a high suction pressure. Thompson et al opined that this suction pressure helps to hold the tissue against the edge of the needle which cuts the cells during multiple passes of the needle.<sup>17</sup> This approach relies on suction and may be stressful

**Table 2:** FNAC - Overall diagnostic accuracy

Criteria	Breast	Thyroid	Lymph node	Others	Overall
Diagnostic accuracy	92.59%	73.68%	93.02%	90%	90.19%
No. of diagnostically superior smears	61	6	75	5	147
No. of diagnostically adequate smears	44	18	68	8	138
No. of diagnostically unsuitable smears	11	13	12	4	40

**Table 3:** FNNAC -Overall diagnostic accuracy

Criteria	Breast	Thyroid	Lymph node	Others	Overall
Diagnostic accuracy	88.88%	89.47%	86.04%	70%	86.92%
No of diagnostically superior smears	59	20	69	3	151
No of diagnostically adequate smears	41	10	62	8	121
No of diagnostically unsuitable smears	16	7	24	6	53

**Table 4:** Pathology of breast lump

Diagnosis	Total
Ductal carcinoma	95
Lobular carcinoma	2
Fibroadenoma	3
Fibrocystic disease	11
Ductal hyperplasia	4
Benign phylloids	1
Total	116

**Table 5:** Analysis of breast lump

Method		Satisfactory		Unsatisfactory	Accuracy
		Superior	Adequate		
FNAC	Benign	7	8	4	92.59%
	Malignant	54	36	7	
FNNAC	Benign	4	7	8	88.88%
	Malignant	55	34	8	

**Table 6:** Analysis of thyroid swelling

Method	Thyroid Swelling	Satisfactory		Unsatisfactory	Accuracy
		Superior	Adequate		
FNAC	Benign	3	10	7	73.68%
	Malignant	3	8	6	
FNNAC	Benign	10	6	4	89.47%
	Malignant	10	4	3	

**Table 7:** Analyses of lymph nodes

Method	Node Status	Satisfactory		Unsatisfactory	Accuracy
		Superior	Adequate		
FNAC	Node positive	44	38	6	93.02%
	Reactive node	31	30	6	
FNNAC	Node positive	40	35	13	86.04%
	Reactive node	29	27	11	

**Table 8:** Analysis of other solid tumours

Method		Satisfactory		Unsatisfactory	Accuracy
		Superior	Adequate		
FNAC	Benign	3	4	2	90%
	Malignant	2	4	2	
FNNAC	Benign	2	4	3	70%
	Malignant	1	4	3	

**Table 9:** Statistical analyses of all solid tumours

Disease	Method	Accuracy %	Sensitivity %	Specificity %	Positive predictive value %	Negative predictive value %
Breast	FNAC	92.59	93.15	87.5	98.55	58.33
	FNNAC	88.88	89.04	87.5	98.48	46.66
Thyroid	FNAC	73.68	71.42	80	90.9	50
	FNNAC	89.47	85.71	100	100	71.42
Node	FNAC	93.02	92	94.4	95.83	89.47
	FNNAC	86.04	84	88.88	91.30	80
Others	FNAC	90	85.71	100	100	75
	FNNAC	70	71.42	66.66	83.33	50

**Table 10:** Case distribution

	Breast	Thyroid	Other solid tumors	Lymphnode
Benign	19	20	9	67
Malignant	97	17	8	88
	116	37	17	155

**Table 11:** FNAC - Overall diagnostic accuracy

Criteria	Breast	Thyroid	Lymph node	Others	Overall
Diagnostic accuracy	92.59%	73.68%	93.02%	90%	90.19%
No of diagnostically superior smears	61	6	75	5	147
No of diagnostically adequate smears	44	18	68	8	138
No of diagnostically unsuitable smears	11	13	12	4	40

**Table 12:** FNNAC -Overall diagnostic accuracy

Criteria	Breast	Thyroid	Lymph node	Others	Overall
Diagnostic accuracy	88.88%	89.47%	86.04%	70%	86.92%
No of diagnostically superior smears	59	20	69	3	151
No of diagnostically adequate smears	41	10	62	8	121
No of diagnostically unsuitable smears	16	7	24	6	53
Total	-	-	-	-	325

**Table 13:** Analysis of breast lump

S.No.	Technique	Diagnostic accuracy	No of superior quality smears
1	FNNAC	88.88%	59
2	FNAC	92.59%	61
3	P value	0.003	0.889

**Table 14:** Analysis of thyroid swelling

Technique	Diagnostic accuracy	No of superior quality smears
FNNAC	89.47%	20
FNAC	73.68%	6
P value	0.001	0.006

**Table 15:** Superiorsmears in thyroid lesions compared to previous studies

Author, Year	FNNAC	FNAC	P-value
All Rizvi et al <sup>13</sup> (2005)	44.7%	20%	<0.05
Santos & Leiman <sup>7</sup> (1988)	44%	8%	<0.05
Present study	54.05%	16.21%	<0.05

**Table 16:** FNNAC and FNAC diagnostic accuracy in thyroidswelling compared to previous studies

Author, Year	FNNAC	FNAC	P value
CV Raghuvver et al in 2002 <sup>3</sup>	89%	75%	>0.05
Mitchell et al in 2007 <sup>15</sup>	81%	86%	>0.05
Carvalho et al <sup>16</sup> in 2009	74.2%	75.8%	0.600
Present study	89.47%	73.68	0.001

thereby resulting in hematomas and discomfort, or it can generate hemorrhagic material, resulting in hemorrhagic cell morphology distortion in the aspirate. This makes the diagnosis of the lesion difficult and may change the course of management.<sup>11</sup>

These problems are overcome by the FNNAC which is lesser traumatic and painful and permits much better control of the needles while doing the procedure.<sup>11,18</sup> It also picks up a smaller amount of tissue but provides good-quality material with retention of cellular architecture.<sup>15,19</sup>

#### 4.1. Breast

On analysing the smears from breast lumps, FNAC was the more suitable methodology for the benign fibrous lesion, since satisfactory smears were more compared with FNNAC. With FNAC, the number of inappropriate smears or the failure rate was decreased. FNAC produced more appropriate material in the event of malignant breast masses. The diagnostic accuracy was more with FNAC for breast lump. The effect was statistically significant ( $p = 0.003$ ) (Table 13).

Raghuvver<sup>8</sup> et al in 2002 evaluated breast lumps and reported that smears with satisfactory material were obtained in 85.19% of cases with FNAC and 70.38% of cases with FNNAC. He opined that FNAC was better to diagnose benign breast disease and FNNAC suited well to diagnose malignant breast disease. Baksh<sup>16</sup> et al in 2004 evaluated breast masses with FNAC and FNNAC and reported that more diagnostic superior smears were with FNNAC and higher diagnostically adequate smears and less unsuitable smears were with FNAC.

#### 4.2. Thyroid

The frequency of better quality smears and diagnostic accuracy were higher from the FNNAC approach when it came to thyroid enlargement, and this difference was statistically significant ( $p < 0.05$ ) (Table 14).

Santos and Leiman in 1988 and Rizvi and Hussain in 2005 reported in their studies that FNNAC yielded more diagnostically superior smears than FNAC in benign and malignant thyroid disease.<sup>8,13</sup> Kamal<sup>12</sup> et al. also reported similar results with high quality smears with less haemorrhage (Table 15).

Raghuvver<sup>8</sup> et al in 2002 evaluated 68 thyroid swellings and reported diagnostic accuracy of 89% for FNNAC and

75% for FNAC. Diagnostic accuracy for thyroid nodules was 81% with FNNAC and 86% with FNAC in a study by Mitchell<sup>20</sup> et al in 2007. Whereas Carvalho<sup>21</sup> et al. in 2009 reported that FNAC and FNNAC provide almost the same diagnostic accuracy. Haddadi-Nezhad<sup>22</sup> et al., in 2003 concluded that FNNAC was not superior to FNAC in thyroid nodules (Table 16).

#### 4.3. Lymph node

On analysing smears from lymph nodes FNAC was observed to be better than FNNAC because of the presence of higher numbers of superior quality smears, and the number of unsuitable smears was lower i.e., the failure rate was lower from FNAC. The diagnostic accuracy was more for FNAC than FNNAC (93.02% vs. 86.04%). Kumara Singh and Sherifdeen in 1995 evaluated the lymph node sampling and reported that both FNAC and FNNAC produce similar results with respect to the cellularity parameter but, FNNAC was found superior on other parameters.<sup>23</sup> Raghuvver<sup>8</sup> et al in 2002 studied 80 lymph node cases and found FNAC with higher diagnostic accuracy (87.5%) than that for FNNAC (81.25%). However, the quality of FNNAC smears was much superior to that of FNAC smears.

In 2000, Ghosh<sup>19</sup> et al observed that FNAC got a bigger number of diagnostically sufficient as well as inappropriate smears than FNNAC, while FNNAC obtained a greater number of diagnostically superior smears. The difference was found to be statistically significant ( $p < 0.05$ ). Braun<sup>18</sup> et al in 1997 also performed a similar study and reported that FNNAC yielded better smears than FNAC. Sanjeev and Siddharaju,<sup>10</sup> performed a lymph node investigation in 2009, and the findings demonstrated FNNAC's technical superiority.

After comparing the overall performance of FNNAC and FNAC in 325 instances, it was discovered that FNNAC produced more superior quality smears than FNAC. The diagnostic accuracy was more with FNAC than FNNAC. The quantity of unsuitable smears was reported to be lesser with FNAC in breast, lymph node and other lesions whereas it was higher in thyroid lesions.

Because it delivered more cellular material and the destruction of certain sheets of cells did not obstruct the diagnosis area, FNAC had higher diagnostic accuracy. This finding was in contradiction with Raghuvver et al observations.<sup>8</sup> He reported FNNAC smears were better with less architectural distortion. Ghosh<sup>19</sup> et al. confirmed this

finding of less architectural distortion in their study of non-aspiration cytology on lymph node and thyroid lesions. FNNAC performs better in this parameter compared to FNAC, as reported by other authors.<sup>7,8</sup>

The diagnostic performance, FNAC was notably more superior in producing diagnostically better smears (n=285, 87.69%), when compared to FNNAC (n=272, 83.69%).

When comparing the two procedures, FNNAC was shown to generate much superior smears with significantly less bleeding. Rizvi<sup>13</sup> et al., as well as other writers, noticed the same thing. When the number of superior quality smears obtained from each method was compared, the FNNAC approach produced more superior quality smears in thyroid lesions. Each strategy has its own set of benefits and drawbacks. Both approaches may be used together to produce high-quality materials with decreased failure rates.<sup>8,24</sup>

## 5. Conclusion

This research concluded that FNNAC was the preferable approach for highly vascular organs like the thyroid because it yields excellent smears with less blood admixtures. Although FNAC smears were more often diagnostic, they typically yielded acceptable rather than excellent grade smears. FNAC was the best option for fibrous lesions of the breast such as fibroadenoma and Phyllodes tumour. The frequency of acceptable smears and the success rate are higher using the FNAC approach for malignant breast masses and lymph node assessment.

## 6. Source of Funding

None.

## 7. Conflict of Interest

None.

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