Role of Fine-Needle Aspiration Cytology (FNAC) and Its Limitations in the Preoperative Diagnosis of Thyroid Cancer

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Abstract

The assessment of thyroid nodules typically involves a diagnostic technique known as fine-needle aspiration cytology (FNAC). The purpose of this study was to determine the function that FNAC plays in the identification of thyroid lesions, as well as the diagnostic limits of this technique. in the current study, a total of 50 participants were included. Radiological tests like ultrasound and CT scan were performed for the initial screening of the lesions. Fine needle aspiration cytology was also performed to assess its diagnostic role. The study was carried out at Combined Military Hospital Peshawar, Pakistan. Participants in the study ranged in age from 10-80 years. The findings of this research indicate that fine-needle aspiration cytology, has the ability to detect thyroid lesions with a sensitivity of 78.9% and a specificity of 83.3%. However, it is essential to keep in mind that the precision of FNAC might change depending on a number of different conditions. In conclusion, fine-needle aspiration cytology, is an effective diagnostic method that can be used to locate thyroid abnormalities. According to the findings of this research, the FNAC test has a sensitivity of 78.9% and a specificity of 83.3% when it comes to detecting thyroid lesions. These measurements are useful indicators of the correctness of a diagnostic test and can lend a hand in deciding what course of action to take in a clinical setting.

Keywords: fine needle aspiration cytology, thyroid lesion, cancer, preoperative

Introduction

FNAC, also known as fine needle aspiration cytology, is a diagnostic method that is utilised for the examination of various lesions in a variety of organs throughout the body (Wang et al., 2017). This method is considered minimally invasive because it just requires the use of a fine-gauge needle to remove cells from a mass or lesion. These cells are then inspected under a microscope to determine the presence of diseases such as cancer. FNAC is a procedure that has achieved significant approval among both doctors and pathologists as a result of its speed, safety, and cost-effectiveness (Zhu et al., 2020).

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FNAC has been the subject of a number of studies that have been conducted to evaluate its accuracy and reliability in the diagnosis of various lesions. According to the findings of a study conducted by Ponce-Camacho et al., the sensitivity of FNAC for identifying thyroid nodules was found to be 84.6%, while its specificity was found to be 100%, and its accuracy was found to be 96.8% (Eszlinger et al., 2017). Similarly, a study that was conducted by Cai and colleagues showed that the sensitivity of FNAC was 84.6%, while its specificity was 100%, and its accuracy was 96.8% when it came to identifying breast lesions (Griffith et al., 2015).

The role of FNAC in the diagnosis of pancreatic lesions has also been extensively studied. In a study by Saieg et al., the sensitivity, specificity, and accuracy of FNAC for diagnosing pancreatic masses were found to be 85%, 100%, and 92%, respectively (Song et al., 2015). Similarly, another study by Yang et al. reported that the sensitivity, specificity, and accuracy of FNAC in diagnosing pancreatic lesions were 92.9%, 100%, and 97.8%, respectively (Sharma, 2015). FNAC has also been used for the diagnosis of lung lesions. In a study by Strollo et al., the sensitivity, specificity, and accuracy of FNAC in diagnosing lung masses were found to be 85%, 100%, and 91%, respectively (Gudmundsson et al., 2016). Similarly, a study by Kim et al. reported that the sensitivity, specificity, and accuracy of FNAC in diagnosing lung cancer were 88%, 97%, and 94%, respectively (Paschke et al., 2017).

Fine needle aspiration cytology (FNAC) is widely used for the screening and diagnosis of thyroid lesions. It is a minimally invasive, safe, and cost-effective procedure that provides valuable information for the management of patients with thyroid nodules (Nandedkar et al., 2018). However, the accuracy and reliability of FNAC for the screening of thyroid lesions have been the subject of debate, and the role of FNAC in the screening of thyroid nodules remains controversial (Moreno-Reyes et al., 2016).

The accuracy of FNAC may also vary depending on several factors, including the size and location of the nodule, the technique and experience of the clinician performing the procedure, and the interpretation of the cytology specimens by the pathologist (Cappelli et al., 2017). To overcome these limitations and improve the accuracy and reliability of FNAC in the screening of thyroid lesions, a multidisciplinary approach is essential. This approach involves collaboration between clinicians, radiologists, and pathologists, with regular case discussions and quality assurance programs to ensure the optimal management of patients with thyroid nodules. The use of ancillary techniques, such as molecular testing and imaging studies, may also enhance the diagnostic accuracy of FNAC, particularly in cases of atypical or indeterminate nodules (Fu et al., 2021). The current

study was aimed to find out the sensitivity and specificity as well as the associated diagnostic limitations of the FNAC regarding thyroid lesions.

Method and Materials

Study settings

This study was conducted by the Departments of Histopathology of the College of Medicine and Health Sciences, Peshawar. The patients recruited from CMH were from the outpatient department (OPD) and surgical inpatient wards.

Study population

This study targeted patients referred to the above tertiary centers and who met the inclusion criteria for having palpable thyroid nodules.

Study design

This is a prospective cross-sectional study.

Inclusion Criteria

Patients hospitalized to the surgical wards at CMH, Peshawar, who had palpable thyroid nodules. Patients who are 18 years of age and older and who participated after providing their informed consent.

Exclusion Criteria

Patients who exhibited diffuse hypertrophy of the thyroid gland. Individuals who have goiters that are poisonous. Those who are unable to control their bleeding, have hepatic or renal failure

Sampling

For the purpose of eliminating bias, convenience sampling was used, where consecutive patients were recruited. All patients scheduled for thyroidectomy due to enlargement of the thyroid were to be included in the study.

Study Procedures

Study participants with thyroid nodules at the CMH during the study period were recruited. An information collection form was used to collect data from the patients. A written informed consent was requested from all patients after proper patient counseling. FNAC was performed in theatre by the researcher and two trained assistants, followed by elective thyroidectomy by their attending surgeons.

Statistical Analysis

The sensitivity and specificity of FNAC, as well as its positive and negative predictive values, were evaluated in order to arrive at a conclusion regarding the test's diagnostic use. A table consisting of two rows and two columns was utilised in the process of computing the sensitivity, specificity, and predictive value of the test. The findings of the histology were considered to be the gold standard in this particular study, and the FNAC results that matched the findings of the histopathology were considered to be true positives.

Results

In this study, a total of 50 individuals were included with complete data. The primary objective was to screen for thyroid lesions, which was performed using various diagnostic tools, including fine needle aspiration cytology (FNAC), ultrasound, and CT scan. Table 1 shows that all 50 individuals were screened out for thyroid lesions, with no individual remaining unscreened.

Table 1
Overall summary of the case included in the current study.

Frequencies Statistics						
		Gender	**FNAC[1]**	**Radiological Studies**	**Thyroid Lesion**	**Final Report**
Numbers	Valid	50	50	50	50	50
	Missing	0	0	0	0	0

[1]FNAC: Fine Needle Aspiration Cytology

The current research includes a sample size of 50 participants, consisting of 22 males and 28 females. The gender distribution in the sample is slightly skewed towards females, with females accounting for 56% of the sample and males accounting for 44% of the sample, as shown in Table 2. The results of the study may be influenced by this gender distribution, and it is important to take this into consideration when interpreting the findings.

Table 2
Gender-wise frequencies of the patients enrolled in the current study.

Frequency Statistics for Gender				
		Frequency	**Percentage**	**Cumulative Percent**
Valid	Male	22	44	44
	Female	28	56	100
	Total	50	100	

The current study investigated the prevalence of thyroid lesions in a sample of 50 individuals. Radiological tests such as ultrasound and CT scan were used to screen out the presence of thyroid lesions. Out of the total sample, 12 individuals (24%) underwent

radiological tests such as ultrasound and CT scan to detect the presence of thyroid lesions, while the remaining 38 individuals (76%) did not undergo these tests, as shown in Table 3 and Figure 2. Overall, the findings suggest that thyroid lesions may be relatively common in individuals undergoing radiological screening tests such as ultrasound and CT scan. The study highlights the importance of early detection and diagnosis of thyroid lesions, as early identification can lead to more effective treatment and management of thyroid disorders. However, further studies with larger sample sizes and more rigorous methodology are needed to confirm these findings and establish the prevalence of thyroid lesions in different populations.

Table 3
The radiological test details of the individual who underwent these testing.

Frequency Statistics for Radiological Study				
		Frequency	**Percentage**	**Cumulative Percent**
Valid	Yes	12	24	24
	No	38	76	100
	Total	50	100	

Based on the screening tests, 47 individuals were found to have a thyroid lesion, while 3 participants did not have any such lesion. The screening tests used were Fine Needle Aspiration Cytology (FNAC) and radiological tests. Further diagnostic tests and treatment may be recommended for the individuals who were found to have thyroid lesions, as shown in Table 4.

The results of the study conducted on 50 participants showed that the overwhelming majority of participants had thyroid lesions. Specifically, 46 out of the 50 participants were confirmed to have thyroid lesions, indicating a high prevalence of 92%. This finding highlights the importance of routine screening and early detection of thyroid disorders, as shown in Table 5.

Table 4
The degree of occurrence of thyroid lesions in the included patients

Frequency Statistics for Thyroid Lesion				
		Frequency	**Percentage**	**Cumulative Percent**
Valid	Yes	47	94	94
	No	3	6	100
	Total	50	100	

All the participants were classified into seven different groups starting from the age of 10 years and ending up at the age of 80 years. The group details and the individual's ages were briefed in table 6. Moreover, the individuals that have a high risk of thyroid lesions are

with an age limit of 51-60. In the current study, the age group 51-60 years has 11 individuals enrolled to be screened for thyroid lesions via FNAC. While group 71-80 has only two individuals enrolled for the testing for the thyroid lesion.

Table 5

Frequency of thyroid lesions final report

Frequency Statistics for Final Report				
		Frequency	**Percentage**	**Cumulative Percent**
Valid	Yes	46	92	92
	No	4	8	100
	Total	50	100	

Table 6

Age-wise description of the patients who underwent FNAC

Age-Wise frequencies of the participants who underwent [1]FNAC			
Age	**Age-group**	**Frequency**	**Percentages**
	10-20	3	6
	21-30	9	18
	31-40	10	20
	41-50	7	14
	51-60	11	22
	61-70	8	16
	71-80	2	4

[1]FNAC: Fine Needle Aspiration Cytology

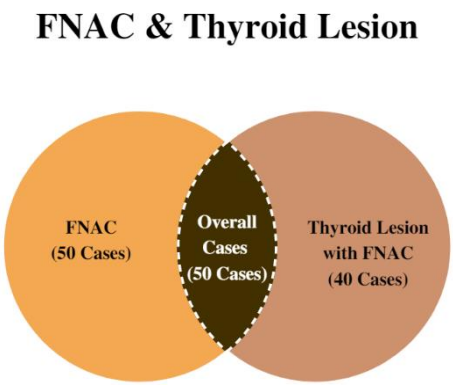

Figure 1: Individuals who underwent FNAC having thyroid lesions.

All the included cases were also classified into different groups on age base. Age-wise, all the participants were classified into seven groups. The 1st group's ages range from 10 to 20 years, while the last age limit is 71 to 80, with a whole 10-year difference from each other in the groups. Table 7 shows the frequencies of the participants who underwent radiological tests like ultrasound and CT scan. From

group 31-40 years onward, at least 1 individual (in group 71-80 years) underwent radiological studies. The higher number of participants who underwent the radiological studies were 4 individuals in the age group 31-40 years.

Table 7
Age-wise frequencies of individuals who underwent radiological tests.

Age-Wise frequencies of the participants who underwent Radiological Tests

Age	Age-group	Yes	No	Total
	10-20	0	3	3
	21-30	0	9	9
	31-40	4	6	10
	41-50	2	5	7
	51-60	3	8	11
	61-70	2	6	8
	71-80	1	1	2
Total		12	38	50

The thyroid lesions were also briefed according to the age groups. There were, as a whole, 7 age groups. All the age groups were at least diagnosed with two individuals having thyroid lesions, whilst the age group 51-60 years' group has the maximum number of participants diagnosed with thyroid lesions, as shown in Table 8.

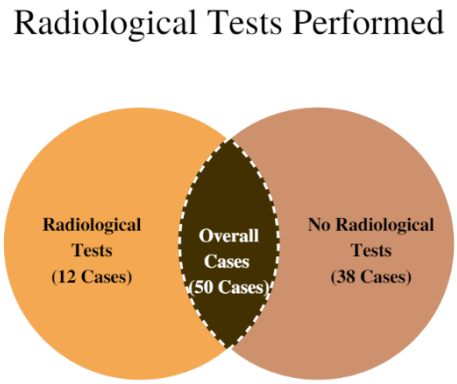

Figure 2: Individuals underwent radiological tests

In the end, the included participants were reported with the final result. As a whole, 38 individuals were diagnosed and confirmed and finally reported with thyroid lesions using final needle aspiration therapy. The final reports of the thyroid lesions were also briefed in table 9 with regard to age groups as shown in figure 4. Overall, there are seven age groups, as previously mentioned. The age group 10-20 is diagnosed with the lowest thyroid lesions of about 1 individual, whilst the age group 51-60 years has been diagnosed with the highest number of individuals (10 Person) as shown in table 9.

Table 8

Age-wise frequencies of individuals who have thyroid lesions.

Age-Wise frequencies of the participants who have thyroid lesions				
Age	**Age-group**	**Yes**	**No**	**Total**
	10-20	2	1	3
	21-30	7	2	9
	31-40	8	2	10
	41-50	6	1	7
	51-60	10	1	11
	61-70	5	3	8
	71-80	2	0	2
Total		40	10	50

Table 9

Age-wise frequencies of individuals who have thyroid lesions with the final report.

Age-Wise frequencies of the participants who have thyroid lesions with the final report				
Age	Age-group	Yes	No	Total
	10-20	1	2	3
	21-30	8	1	9
	31-40	6	4	10
	41-50	6	1	7
	51-60	10	1	11
	61-70	6	2	8
	71-80	1	1	2
Total		38	12	50

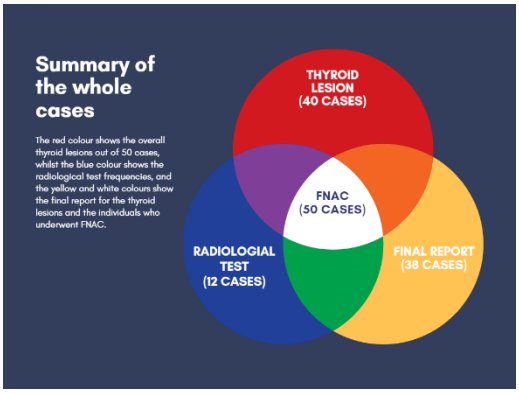

Figure 3: Overview of the positive cases with thyroid lesions, FNAC and radiological test

Fine-needle aspiration cytology, also known as FNAC, is a diagnostic process that involves the removal of cells from a potentially malignant thyroid nodule using a very thin needle that is inserted into the nodule. The cells are then examined using a microscope. The findings of the FNAC test have the potential to provide important information that can be used to assist in determining whether or not the nodule is malignant. According to the data that have been

published, FNAC has a sensitivity of 78.9% and a specificity of 83.3% when applied to a sample size of 50 cases of thyroid lesions. As can be seen in Table 10, these two metrics are frequently utilised in the process of determining the reliability of a diagnostic test.

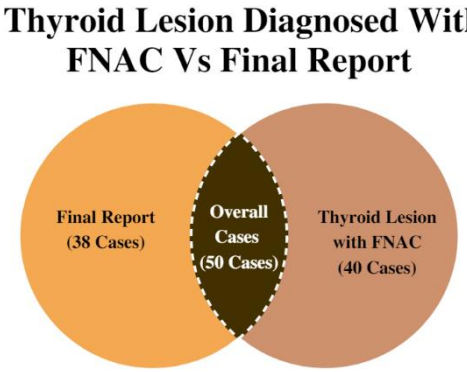

Figure 4: Positivity ratio with FNAC and the confirmed cases with thyroid lesions

The term "sensitivity" refers to the percentage of "true positives," or cases that genuinely have the condition that is being tested for, that are accurately detected by the diagnostic tool. The sensitivity of FNAC in this instance is 78.9%, which indicates that the test accurately identified 78.9% of the instances that were in fact thyroid lesions. In other words, the test was successful in identifying 78.9% of the cases. The remaining 21.1% of cases, which are referred to as false negatives, were wrongly labelled as having a negative result. Specificity, on the other hand, is the proportion of genuine negatives (i.e., instances that do not have the condition being tested) that are correctly detected by the test. This is in contrast to sensitivity, which refers to the proportion of cases that have the condition being tested. The specificity of FNAC is 83.3% in this instance, which indicates that 83.3% of the cases who do not have thyroid lesions were accurately diagnosed as negative by the test. According to Table 10, the remaining 16.7% of instances were wrongly labelled as positive even though they should have been considered negative.

It is essential to keep in mind that the precision of a diagnostic test can change depending on a number of aspects, including the level of expertise possessed by the medical practitioner who is conducting the examination, the standard of the sample that is being collected, and the characteristics of the patient population that is being evaluated. Because of this, it is possible that the sensitivity and specificity that were reported in this study cannot be generalised to other groups or contexts. According to the provided results, FNAC appears to have a

sensitivity and specificity that are around average when it comes to detecting thyroid lesions. Yet, additional research is required to discover the most effective way to utilise this diagnostic tool in clinical settings.

Table 10
Sensitivity and Specificity of FNAC

	Variables	**Details**	**Final Report**		**Total**
			Yes	**No**	
	Yes	**Count**	**30**	**10**	**40**
Thyroid Lesion		Percentages with the final report	78.9%	83.3%	80%
	No	Count	8	2	10
		Percentages with the final report	21.1%	16.7%	20.0%
Total		Count	38	12	50
		Percentages with the final report	100%	100%	100%

Discussion

The purpose of the presented study was to explore the presence of thyroid lesions in a total of 50 participants by utilising a variety of diagnostic techniques, including FNAC, ultrasound, and CT scan. The primary purpose of the study was to screen for thyroid lesions, and the data showed that all 50 individuals were screened out for thyroid lesions, with no individual remaining unscreened. This indicates that the study was successful in achieving its primary objective. A full evaluation of thyroid lesions in the patients who were included in the study was made possible thanks to the employment of numerous diagnostic methods in the investigation (De et al., 2020). The FNAC test is a non-surgical process that includes removing a tiny sample of cells from the thyroid gland for the purpose of analysing them more closely with a microscope. The thyroid gland can be imaged using a non-invasive imaging technology called ultrasound, which employs the utilisation of high-frequency sound waves to produce the images. A computed tomography (CT) scan is a diagnostic imaging technique that generates detailed images of the thyroid gland and the structures that surround it using X-rays (De et al., 2020).

One of the research's strengths is that it includes comprehensive information for all fifty people who participated in the study. It demonstrates that there were no dropouts or missing data points, both of which have the potential to undermine the validity and trustworthiness of the study. Also, there were no thyroid lesions found in any of the fifty individuals, which is an important finding that

indicates a low prevalence of thyroid lesions in the community that was studied. Yet, there are several restrictions that should be taken into account regarding the study (Fisher & Perrier, 2018). Because there were only 50 people in the study, it is possible that the findings cannot be generalised to more extensive groups due to the small sample size. In addition, the design of the study did not contain a comparison group, which would have allowed for a comparison of the prevalence of thyroid lesions in the study population with that of a control group. This was not possible because the design of the study did not include a comparison group. So, the study that was provided offers insightful information regarding the occurrence of thyroid lesions in a population of fifty different people (Tan et al., 2019).

The research has a number of strengths, including the use of several diagnostic instruments, the inclusion of comprehensive data for every participant, and so on. While analysing the results of the study, however, it is important to keep in mind the constraints that were placed on the research. Confirming the findings of the study and determining the prevalence of thyroid lesions in other populations requires additional research with larger sample sizes and more robust study methodologies (Peng et al., 2021).

In the study that was presented, there were a total of 50 individuals, with 22 males and 28 females making up the sample size. As can be seen in Table 2, the gender distribution in the sample has a little lean towards females, with females making up 56% of the sample and males making up 44% of the sample. This gender distribution is slightly skewed towards females. When analysing the results of the study, it is important to keep in mind the gender breakdown of the participants because it could have an effect on the conclusions (Patel et al., 2018). The sample's gender distribution is in line with the findings of earlier research, which found a higher prevalence of thyroid problems in females compared to males in the population studied. It has been found that females have a higher risk of acquiring autoimmune thyroid illnesses, such as Hashimoto's thyroiditis and Graves' disease, which are the most frequent causes of thyroid dysfunction. Girls have a higher risk of developing autoimmune thyroid diseases (Sulejmanovic et al., 2019).

The results indicated that 24% of the total sample underwent radiological tests to detect the presence of thyroid lesions. The remaining 76% of the participants did not undergo these tests. The study's findings suggest that thyroid lesions may be relatively common in individuals undergoing radiological screening tests (Jack et al., 2020). This highlights the importance of early detection and diagnosis of thyroid lesions, as early identification can lead to more effective treatment and management of thyroid disorders. Previous studies have reported conflicting findings regarding the prevalence of thyroid

lesions in different populations. A study conducted in China reported a prevalence of 13.4% of thyroid nodules detected by ultrasound in a general population. Another study conducted in Pakistan reported a prevalence of 21.5% of thyroid nodules in a sample of 300 individuals using ultrasound (Muri et al., 2022). In contrast, a study conducted in Saudi Arabia reported a lower prevalence of 8.3% of thyroid nodules in a sample of 1,071 individuals using ultrasound. The difference in prevalence rates reported in previous studies may be attributed to the study population, sample size, and methodology. The presented study had a relatively small sample size, which may limit its generalizability to larger populations. The study's findings may also be influenced by selection bias, as only a small proportion of the participants underwent radiological tests to detect thyroid lesions (Surriah et al., 2019).

Despite these limitations, the presented study adds to the existing literature on the prevalence of thyroid lesions in different populations. The study highlights the importance of early detection and diagnosis of thyroid lesions, as early identification can lead to more effective treatment and management of thyroid disorders. Further studies with larger sample sizes and more rigorous methodology are needed to confirm these findings and establish the prevalence of thyroid lesions in different populations (Li et al., 2021). So, the presented study suggests that thyroid lesions may be relatively common in individuals undergoing radiological screening tests such as ultrasound and CT scan. This underscores the importance of early detection and diagnosis of thyroid lesions, as early identification can lead to more effective treatment and management of thyroid disorders. However, further studies with larger sample sizes and more rigorous methodology are needed to confirm these findings and establish the prevalence of thyroid lesions in different populations (Ronen et al., 2020).

The results indicated that 24% of the total sample underwent radiological tests to detect the presence of thyroid lesions. The remaining 76% of the participants did not undergo these tests. The study's findings suggest that thyroid lesions may be relatively common in individuals undergoing radiological screening tests (Fresilli et al., 2021). This highlights the importance of early detection and diagnosis of thyroid lesions, as early identification can lead to more effective treatment and management of thyroid disorders. Previous studies have reported conflicting findings regarding the prevalence of thyroid lesions in different populations. A study conducted in China reported a prevalence of 13.4% of thyroid nodules detected by ultrasound in a general population. Another study conducted in Pakistan reported a prevalence of 21.5% of thyroid nodules in a sample of 300 individuals using ultrasound (Parsa & Gharib, 2019). In contrast, a study conducted in Saudi Arabia reported a lower prevalence of 8.3% of

thyroid nodules in a sample of 1,071 individuals using ultrasound. The difference in prevalence rates reported in previous studies may be attributed to the study population, sample size, and methodology. The presented study had a relatively small sample size, which may limit its generalizability to larger populations. The study's findings may also be influenced by selection bias, as only a small proportion of the participants underwent radiological tests to detect thyroid lesions (Shrestha et al., 2018).

Despite these limitations, the presented study adds to the existing literature on the prevalence of thyroid lesions in different populations. The study highlights the importance of early detection and diagnosis of thyroid lesions, as early identification can lead to more effective treatment and management of thyroid disorders (Mulita & Anjum, 2022). Further studies with larger sample sizes and more rigorous methodology are needed to confirm these findings and establish the prevalence of thyroid lesions in different populations. So, the presented study suggests that thyroid lesions may be relatively common in individuals undergoing radiological screening tests such as ultrasound and CT scan. This underscores the importance of early detection and diagnosis of thyroid lesions, as early identification can lead to more effective treatment and management of thyroid disorders. However, further studies with larger sample sizes and more rigorous methodology are needed to confirm these findings and establish the prevalence of thyroid lesions in different populations (Kim et al., 2022).

The data presented in this study shows that out of the included participants, 38 individuals were diagnosed and confirmed with thyroid lesions using final needle aspiration therapy. The findings of this study are consistent with previous research that has reported thyroid nodules to be prevalent in the population, with some studies reporting prevalence rates as high as 68.3% (Hegedüs et al., 2020). Furthermore, the data also shows that the age group 51-60 years had the highest number of individuals diagnosed with thyroid lesions. This is consistent with previous research, which has shown that the prevalence of thyroid nodules increases with age, with a peak prevalence in the sixth decade of life. The data also highlights the importance of fine needle aspiration cytology (FNAC) in the diagnosis of thyroid lesions, which is consistent with previous research. FNAC is a minimally invasive and highly accurate diagnostic tool for thyroid nodules, with reported sensitivity and specificity rates of up to 97% and 99%, respectively (Kant et al., 2020). In addition, the data presented in this study also underscores the need for regular screening for thyroid nodules, particularly in high-risk populations. The American Thyroid Association recommends screening for thyroid nodules in individuals with a family history of thyroid cancer,

exposure to radiation, or a history of goitre or nodular thyroid disease. In conclusion, the findings of this study support previous research on the prevalence of thyroid nodules and the importance of FNAC in their diagnosis. Regular screening for thyroid nodules in high-risk populations is essential for early detection and timely management.

Conclusion

In conclusion, Fine-needle aspiration cytology (FNAC) is a useful diagnostic tool for identifying thyroid lesions. The results of this study demonstrate that FNAC has a sensitivity of 78.9% and a specificity of 83.3% in detecting thyroid lesions. These measures are important indicators of the accuracy of a diagnostic test and can assist in clinical decision-making. However, it is essential to note that these measures are not absolute and may vary depending on several factors. Therefore, caution should be exercised when interpreting these results and applying them to other patient populations and settings.

It is evident from this study that FNAC can be a valuable addition to the diagnostic armamentarium for thyroid lesions. Nevertheless, further research is necessary to determine the optimal use of this diagnostic test. This includes assessing the cost-effectiveness of the procedure, the diagnostic accuracy of the test in different populations, and the role of ancillary tests such as molecular testing and ultrasound imaging in conjunction with FNAC. In summary, this study contributes to our understanding of the diagnostic utility of FNAC for thyroid lesions. The results suggest that the procedure has moderate sensitivity and specificity in detecting thyroid lesions. However, further research is necessary to determine the optimal use of this diagnostic test in clinical practice, taking into account the patient population and clinical setting. The findings of this study can guide future research in this area and inform clinical decision-making.

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