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Image-Guided Fine-Needle Aspiration Cytology of Intra-Abdominal Lesions: An Eight-Year Experience from a Tertiary Care Centre.

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Abstract
Background: Image-guided fine-needle aspiration cytology (FNAC) is a minimally invasive method for evaluating deep-seated intra-abdominal lesions. This study assessed the cytological spectrum and diagnostic performance of image-guided FNAC over eight years at a tertiary care centre. ***Methods:*** This ambispective study included 660 intra-abdominal lesions sampled between 2010 and 2017 in the Department of Pathology, Goa Medical College. FNAC was performed under ultrasonographic or computed tomography guidance using a 22-gauge needle. Smears were stained with haematoxylin and eosin and May–Grünwald–Giemsa stains. Cytological findings were classified as benign, malignant or inconclusive. Histopathological correlation was available in 58 cases. ***Results:*** The study included 392 males and 268 females. Most patients were aged 41–70 years. Computed tomography guided 427 procedures, while ultrasonography guided 233. The hepatobiliary system was the most commonly sampled site, followed by the retroperitoneum, female genital tract and kidneys. Malignant lesions formed the largest category, with 342 cases, followed by 183 inconclusive and 135 benign lesions. ***Conclusion:*** Image-guided FNAC is a useful and reliable first-line diagnostic procedure for intra-abdominal lesions. Careful radiological targeting, adequate sampling and cytological-radiological correlation are essential for improving diagnostic yield and reducing inconclusive results in routine tertiary-care practice.

Keywords: Fine-needle aspiration cytology; intra-abdominal lesions; image guidance; computed tomography; ultrasonography; cytopathology; diagnostic accuracy.

INTRODUCTION
Intra-abdominal lesions include a wide range of inflammatory, infective, benign and malignant conditions arising from the liver, gallbladder, pancreas, spleen, kidneys, adrenal glands, gastrointestinal tract, ovaries, retroperitoneum, lymph nodes and surrounding soft tissues. Patients with these lesions may present with abdominal pain, loss of appetite, weight loss, fever, jaundice, abdominal distension or a palpable mass. However, many lesions remain clinically silent until they reach an advanced stage and are detected incidentally during radiological examination. Because the abdominal cavity contains several closely situated organs and major blood vessels, determining the exact site and nature of a deeply located lesion through clinical examination alone can be difficult. A reliable tissue diagnosis is therefore important for differentiating neoplastic from non-neoplastic lesions and for planning suitable treatment.

Fine-needle aspiration cytology (FNAC) is a well-established diagnostic method that uses a thin needle to obtain cellular material from a suspected lesion. It is generally rapid, minimally invasive, economical and well tolerated by patients. Compared with open surgical biopsy, FNAC causes less tissue injury, usually requires little recovery time and can provide an early diagnosis. It may help clinicians decide whether a patient requires surgery, chemotherapy, radiotherapy, antimicrobial treatment or further diagnostic investigation. FNAC may also be used to investigate suspected recurrence or metastasis in patients with a previously diagnosed malignancy. Earlier comparative research demonstrated that FNAC can provide rapid and accurate diagnoses in radiologically detected abdominal lesions, although core biopsy may offer additional architectural information in selected conditions [1].

Conventional FNAC is relatively straightforward when a lesion is superficial and easily palpable. Intra-abdominal lesions, however, are commonly deep seated, small, non-palpable or located near major blood vessels, bowel loops and other important structures. Blind aspiration in such circumstances may result in inadequate sampling or injury to nearby organs. The introduction of ultrasonography and computed tomography guidance has substantially improved the ability to sample these lesions safely and precisely. Imaging enables the operator to identify the exact location, size, depth and internal characteristics of a lesion before aspiration. It also helps in selecting a safe needle path that avoids major vessels and adjacent organs. Studies of deep thoracic and abdominal masses have shown that ultrasonography- and computed tomography-guided FNAC are useful for obtaining diagnostic material from lesions that would otherwise be difficult to access [2].

Ultrasonography is commonly used for guiding aspiration because it is widely available, relatively inexpensive, free from ionising radiation and capable of providing real-time visualisation of the needle. The movement of the needle can be monitored continuously until its tip enters the selected part of the lesion. Ultrasound can also distinguish solid from cystic areas and identify necrosis, haemorrhage and vascular structures. This allows viable solid areas to be targeted and reduces the likelihood of collecting only blood, necrotic material or cyst contents. Computed tomography guidance is particularly helpful for lesions that are poorly visualised on ultrasound, obscured by bowel gas, located deep within the retroperitoneum or surrounded by anatomically complex structures. The choice between these imaging methods generally depends on the site of the lesion, its radiological appearance, available facilities and the experience of the radiologist and cytopathologist [3,4].

Image-guided FNAC has been applied successfully to lesions of the liver, gallbladder, pancreas, kidneys, ovaries, retroperitoneum and intra-abdominal lymph nodes. It can identify primary malignancies, metastatic tumours, lymphomas, benign neoplasms, abscesses, granulomatous inflammation and other non-neoplastic conditions. In a large series of 500 image-guided aspirations, the method was found to be useful for evaluating space-occupying lesions and assisting clinical management [3]. Similarly, studies from tertiary care institutions have reported that combining FNAC with ultrasound or computed tomography improves diagnostic yield and helps achieve a definite diagnosis in most deep-seated lesions [4,5]. Long-term institutional experience has also demonstrated the usefulness of ultrasound-guided aspiration in evaluating focal lesions of solid abdominal organs, particularly the liver and pancreas [6].

The diagnostic value of image-guided FNAC is influenced by several factors. These include the size and depth of the lesion, the presence of necrosis or fibrosis, the number of needle passes, the selection of the target area, the method of smear preparation and the experience of the professionals performing and interpreting the procedure. Inadequate samples may occur when the lesion is very small, predominantly cystic, extensively necrotic or technically difficult to reach. Close cooperation between the radiologist and cytopathologist is therefore essential. Radiological findings guide accurate localisation, while cytological evaluation determines whether the aspirated material is representative and sufficient for diagnosis. When facilities are available, rapid on-site evaluation can permit immediate assessment of specimen adequacy and allow additional passes to be performed during the same sitting.

Conventional cytological smears remain the basic method for examining aspirated material. However, cell-block preparation can provide additional diagnostic information by preserving tissue fragments and creating sections similar to histopathology. Cell blocks may demonstrate glandular arrangement, papillary architecture, stromal material and other patterns that are not always clearly visible in routine smears. They also permit the use of special stains and immunocytochemistry, which may assist in identifying the primary origin of a poorly differentiated or metastatic tumour. Studies have shown that combining cytological smears with cell-block preparation can improve diagnostic interpretation and reduce uncertainty in abdominal masses [7,8]. Nevertheless, histopathological examination remains necessary when tissue architecture is essential, when cytology is inadequate or inconclusive, or when cytological and radiological findings are inconsistent.

Although image-guided FNAC has several advantages, institutional data regarding its diagnostic spectrum, adequacy rate, organ-wise distribution and long-term performance remain important. Variations in patient population, disease pattern, referral practices, available imaging facilities and professional expertise may influence the findings reported by different centres. Reviewing experience over an extended period can reveal the most frequently aspirated organs, common cytological diagnoses, causes of inadequate sampling and changes in the use of the procedure over time. Such information can also support improvements in sampling, smear preparation, reporting and multidisciplinary coordination.

Therefore, the present study, titled "Image-Guided Fine-Needle Aspiration Cytology of Intra-Abdominal Lesions: An Eight-Year Experience from a Tertiary Care Centre," was undertaken to evaluate the cytomorphological spectrum of image-guided FNAC specimens obtained from intra-abdominal lesions over eight years. The study also aims to examine the distribution of lesions according to anatomical site, assess specimen adequacy, classify lesions into non-neoplastic and neoplastic categories and determine the practical role of image-guided FNAC in the diagnosis and management of patients with intra-abdominal masses.

MATERIALS AND METHODS

Study design and setting

This ambispective, hospital-based cytopathological study was conducted in the Department of Pathology, Goa Medical College, Bambolim, Goa, India. It included both retrospectively retrieved and prospectively collected cases investigated over eight years, from January 2010 to December 2017. The study evaluated the cytomorphological spectrum and diagnostic utility of image-guided fine-needle aspiration cytology in patients with intra-abdominal lesions.

Study population and sample size

A total of 660 image-guided fine-needle aspiration cytology specimens obtained from intra-abdominal lesions were included. The study population comprised patients of all age groups and both sexes who underwent ultrasonography-guided or computed tomography-guided FNAC during the study period.

The lesions arose from the hepatobiliary system, spleen, pancreas, kidneys, adrenal glands, female genital tract, retroperitoneal lymph nodes, non-nodal retroperitoneal tissues, gastrointestinal tract, mesentery, omentum, psoas region, undescended intra-abdominal testes and paravesical region.

The study sample represented all eligible intra-abdominal FNAC specimens received by the Department of Pathology during the defined study period. A formal sample-size calculation was not performed because the study included the complete set of eligible cases available during the eight-year period.

Eligibility criteria

Inclusion criteria

The study included:

1. Patients with radiologically identified intra-abdominal lesions who underwent ultrasonography-guided or computed tomography-guided FNAC.
2. Patients of any age and either sex.
3. FNAC specimens obtained from solid, cystic or mixed intra-abdominal lesions.
4. Cases with adequate clinical, radiological and cytological information for diagnostic evaluation.
5. Cases with histopathological follow-up, whenever biopsy or surgical excision was subsequently performed.

Exclusion criteria

The thesis did not separately document formal exclusion criteria. For manuscript submission, the institutional records should be reviewed to confirm whether the following cases were excluded:

1. Lesions that were not intra-abdominal in location.
2. Unguided FNAC procedures.
3. Cases lacking essential clinical, radiological or cytological records.
4. Patients in whom the procedure was contraindicated because of an uncorrected coagulation abnormality.
5. Duplicate samples obtained from the same lesion during the same diagnostic episode.

Importantly, specimens reported as inadequate or inconclusive were retained in the overall study population because specimen adequacy was one of the outcomes evaluated.

Clinical and radiological assessment

Relevant demographic and clinical information, including age, sex, presenting features, anatomical site of the lesion and available clinical diagnosis, was recorded for each patient. Radiological findings were reviewed before the procedure to establish the location, size, depth and accessibility of the lesion and to identify a safe needle trajectory.

Radiological guidance was provided through either ultrasonography or computed tomography. The imaging modality was selected according to the anatomical location, depth and radiological visibility of the lesion. Ultrasonography was used for lesions that could be adequately visualised in real time, whereas computed tomography was used mainly for deep-seated, small or anatomically difficult lesions.

Pre-procedural assessment

All FNAC procedures were performed on an inpatient basis. Informed consent was obtained before the procedure. The coagulation profile was reviewed to minimise the risk of procedure-related haemorrhage. Bleeding time, clotting time, platelet count and prothrombin time were required to be within acceptable limits before aspiration.

The patient was transferred to the imaging room, where pulse rate and blood pressure were recorded before the procedure. Patient cooperation was ensured, and the procedure and breathing instructions were explained. The patient was positioned according to the anatomical site of the lesion and the safest radiological approach.

Equipment

The FNAC procedure was performed using:

- A 22-gauge, 90-mm lumbar puncture needle
- A 10-mL disposable syringe
- A modified Cameco syringe-piston holder
- Clean glass slides

- Betadine and spirit for skin disinfection
- Ether and absolute ethyl alcohol for wet fixation
- Reagents for haematoxylin and eosin and May–Grünwald–Giemsa staining

The manufacturers and model numbers of the ultrasonography and computed tomography equipment were not reported in the thesis and should be added from departmental records, where available.

Image-guided fine-needle aspiration procedure

The patient was placed in the most suitable position for radiological examination and needle access. The lesion was localised using ultrasonography or computed tomography. A skin marker was placed when required to identify the planned point of needle entry. Local anaesthesia was not routinely administered.

The skin overlying the selected puncture site was cleaned with betadine and spirit and allowed to dry. A 22-gauge lumbar puncture needle was attached to a 10-mL disposable syringe and mounted on a modified Cameco syringe holder.

The patient was instructed to hold their breath when required, particularly during aspiration of lesions affected by respiratory movement. The needle was advanced along the predetermined path, and the position of the needle tip within the target lesion was confirmed by ultrasonography or computed tomography.

Negative pressure was generated by partially withdrawing the syringe plunger. The needle was moved gently backwards and forwards in different directions within the lesion to obtain representative material. This multidirectional movement was avoided in splenic lesions to reduce the risk of haemorrhage. Suction was released before withdrawing the needle to prevent contamination of the needle tract and loss of aspirated material into the syringe barrel.

The number of passes performed for each lesion was not stated in the thesis. Therefore, this information should not be added unless it can be verified from the original procedural records.

Post-procedural care

After needle withdrawal, firm pressure was applied to the puncture site to control minimal bleeding. The site was sealed using tincture of benzoin. Patients were monitored for approximately 6–24 hours for procedure-related complications, including pain, bleeding, hypotension or signs of circulatory instability.

The thesis did not provide a separate numerical record of complications. Therefore, complication frequency should only be reported in the manuscript if it can be confirmed from the original clinical or radiological records.

Preparation of cytological smears

After completion of the aspiration, the needle was detached from the syringe. The syringe was filled with air, and the needle was reattached. The aspirated material was expelled gently onto three to five clean glass slides, depending on the volume of the specimen.

Thin smears were prepared by placing a second glass slide over the aspirated material and applying gentle, uniform pressure. The two slides were then drawn apart rapidly to distribute the material evenly and minimise cellular distortion.

Most smears were immediately wet-fixed in a freshly prepared solution containing equal volumes of ether and absolute ethyl alcohol. The smears were fixed for a minimum of two hours and subsequently stained with haematoxylin and eosin. Additional smears were air-dried and stained using May–Grünwald–Giemsa stain.

When the aspirated specimen was predominantly fluid, it was centrifuged, and smears were prepared from the resulting sediment. The centrifugation speed, duration and type of centrifuge were not stated in the thesis and should be inserted only when supported by laboratory records.

Cytomorphological evaluation

All stained smears were examined under light microscopy in the Department of Pathology. Cytological interpretation was performed in conjunction with the available clinical history and radiological findings. Each specimen was evaluated for:

- Overall cellularity and specimen adequacy
- Cellular arrangement and tissue architecture
- Nuclear and cytoplasmic features
- Background material
- Inflammatory, necrotic, haemorrhagic or mucinous components
- Evidence of benign or malignant neoplasia
- Features suggesting primary or metastatic malignancy

The cytological findings were categorised into the following broad diagnostic groups:

1. **Benign lesions**
    - Benign neoplastic lesions
    - Non-neoplastic and inflammatory lesions
2. **Malignant lesions**
    - Primary malignant lesions
    - Metastatic malignant lesions
    - Specimens reported as positive for malignancy when further typing was not possible
3. **Inconclusive lesions**
    - Inadequate or scanty aspirates
    - Specimens showing atypical cells in which malignancy could not be excluded

An aspirate was considered inadequate when the cellular material was insufficient to establish a reliable cytological diagnosis. The thesis did not provide a predefined organ-specific minimum cellularity criterion; therefore, adequacy was based on the cytopathologist's assessment of whether the material was representative and diagnostically interpretable.

Anatomical and diagnostic classification

Cases were analysed according to age, sex, anatomical site, imaging modality and cytological diagnosis. Organ-specific diagnoses were recorded for lesions of the liver, gallbladder, common bile duct, spleen, pancreas, kidney, adrenal gland, ovary, uterus, retroperitoneal lymph nodes, other retroperitoneal tissues, gastrointestinal tract, mesentery, omentum, psoas region, undescended testis and paravesical region.

Malignant lesions were further classified, wherever cytomorphology permitted, into primary malignancies, metastatic malignancies and lesions positive for malignancy without definitive tumour typing.

Histopathological correlation

Histopathological correlation was performed in patients who subsequently underwent biopsy or surgical excision. Histopathological examination was treated as the reference standard. A total of 58 cases had corresponding histopathological material available for comparison.

For diagnostic performance analysis, cases were classified as:

- **True positive:** Cytology and histopathology both indicated malignancy.
- **True negative:** Cytology and histopathology both indicated a benign or non-neoplastic lesion.
- **False positive:** Cytology indicated malignancy, but histopathology showed a benign or non-neoplastic lesion.
- **False negative:** Cytology was benign, negative or inconclusive, but histopathology demonstrated malignancy.

Cases lacking histopathological follow-up were included in the descriptive cytological analysis but excluded from calculations of diagnostic accuracy.

Study outcomes

The primary outcome was the cytomorphological distribution of image-guided FNAC diagnoses among intra-abdominal lesions.

Secondary outcomes included:

- Age and sex distribution
- Organ-wise distribution of aspirated lesions
- Proportion of procedures performed under ultrasonography and computed tomography guidance
- Proportion of benign, malignant and inconclusive aspirates
- Distribution of primary and metastatic malignancies
- Specimen inadequacy rate
- Cytohistopathological concordance
- Diagnostic sensitivity
- Diagnostic specificity
- Positive predictive value
- Negative predictive value
- Overall diagnostic accuracy

Statistical Analysis

Data were entered into a structured database and checked for completeness and consistency before analysis. Statistical analysis was performed using statistical software and version 26. As the study mainly aimed to describe the clinicopathological and cytological spectrum of intra-abdominal lesions, the analysis was primarily descriptive.

Patient age was recorded as a continuous variable and was also grouped into the following categories: 0–10, 11–20, 21–30, 31–40, 41–50, 51–60, 61–70 and more than 70 years. Age was summarised using the mean for individual diagnostic categories, as available in the study records. Categorical variables, including sex, anatomical site, type of imaging guidance, cytological category and final cytological diagnosis, were summarised as frequencies and percentages.

The proportions of procedures performed under ultrasonographic and computed tomography guidance were calculated using the total number of included cases as the denominator. The organ-wise distribution of lesions was similarly expressed as frequencies and percentages of the total 660 cases.

RESULTS

A total of 660 patients with intra-abdominal lesions underwent image-guided fine-needle aspiration cytology during the eight-year study period. The patients included 392 males (59.39%) and 268 females (40.61%), giving a male-to-female ratio of approximately 1.46:1.

The age distribution ranged from the first decade of life to more than 70 years. The largest number of patients belonged to the 51–60-year age group, accounting for 153 cases (23.18%). This was followed by the 41–50-year age group with 134 cases (20.30%) and the 61–70-year age group with 118 cases (17.88%). Overall, 405 patients (61.36%) were aged between 41 and 70 years. Only 51 patients (7.73%) were aged 20 years or younger.

Table 1. Age- and sex-wise distribution of patients undergoing image-guided FNAC

Age group, years	Male, n	Female, n	Total, n	Percentage
0–10	21	6	27	4.09
11–20	10	14	24	3.64
21–30	25	32	57	8.64
31–40	53	40	93	14.09
41–50	67	67	134	20.30
51–60	104	49	153	23.18
61–70	79	39	118	17.88
>70	33	21	54	8.18
Total	392	268	660	100.00

Computed tomography was the more commonly used imaging modality, guiding 427 procedures (64.70%). Ultrasonography was used in 233 cases (35.30%).

The hepatobiliary system was the most frequently aspirated anatomical group, accounting for 313 cases (47.42%). This group included 307 liver lesions, three gallbladder lesions and three common bile duct lesions. Retroperitoneal lesions constituted the second-largest group, with 102 cases (15.46%), including 70 retroperitoneal lymph-node lesions and 32 other retroperitoneal masses.

Other intra-abdominal sites accounted for 73 cases (11.06%), while lesions of the female genital system accounted for 65 cases (9.85%). Renal lesions represented 60 cases (9.09%). Splenic, pancreatic and adrenal lesions were less common.

Table 2. Imaging guidance and anatomical distribution of the lesions

Characteristic	Number of cases	Percentage
Imaging modality		
Ultrasonography	233	35.30
Computed tomography	427	64.70
Anatomical site		
Hepatobiliary system	313	47.42
Retroperitoneum	102	15.46
Other intra-abdominal sites	73	11.06
Female genital system	65	9.85
Kidney	60	9.09
Spleen	25	3.79
Pancreas	13	1.97
Adrenal gland	9	1.36
Total	660	100.00

The 73 lesions classified under other intra-abdominal sites included gastrointestinal tract lesions (n=46), mesenteric lesions (n=9), omental lesions (n=10), psoas-region lesions (n=4), intra-abdominal undescended testes (n=3) and a paravesical lesion (n=1).

Of the 660 aspirates, 342 cases (51.82%) were classified as malignant. Benign lesions accounted for 135 cases (20.45%), while 183 aspirates (27.73%) were inconclusive.

Among the benign lesions, 33 cases were benign neoplasms and 102 were non-neoplastic lesions. The malignant category included 200 primary malignancies, 114 metastatic malignancies and 28 specimens reported as positive for malignancy without definitive tumour typing.

The inconclusive category comprised 157 specimens with inadequate material and 26 specimens showing atypical cells in which malignancy could not be excluded. Therefore, the overall inadequate-sampling rate was 23.79%.

Table 3. Overall cytological classification of intra-abdominal lesions

Major category	Cytological subgroup	Number of cases	Percentage of all cases
Benign	Benign neoplastic lesions	33	5.00
	Non-neoplastic lesions	102	15.45
	Subtotal	**135**	**20.45**
Malignant	Primary malignancies	200	30.30
	Metastatic malignancies	114	17.27
	Positive for malignancy, not otherwise typed	28	4.24
	Subtotal	**342**	**51.82**
Inconclusive	Inadequate material	157	23.79
	Atypical cells or malignancy not excluded	26	3.94
	Subtotal	**183**	**27.73**
Total		**660**	**100.00**

The liver was the most commonly aspirated organ, with 307 cases. Of these, 160 were malignant, 56 were benign and 91 were inconclusive. Metastatic tumours were the most frequent malignant hepatic lesions, accounting for 83 cases. Hepatocellular carcinoma was diagnosed in 54 cases. Among the non-neoplastic hepatic lesions, pyogenic abscess was the most frequent diagnosis, with 31 cases, followed by tuberculous abscess in eight cases.

Of the 13 pancreatic lesions, eight were diagnosed as adenocarcinoma, one as a solid pseudopapillary epithelial neoplasm and one as granulomatous inflammation. Three pancreatic aspirates were inconclusive.

Renal lesions included 12 benign, 29 malignant and 19 inconclusive cases. Renal cell carcinoma was the most common specifically typed renal malignancy, accounting for 14 cases, followed by Wilms tumour in six cases.

Among the 52 ovarian lesions, 12 were benign, 19 were malignant and 21 were inconclusive. Papillary adenocarcinoma was the leading malignant diagnosis, with 14 cases. Serous cystadenoma was the most common benign ovarian tumour, with eight cases.

Of the 70 retroperitoneal lymph-node lesions, 50 were malignant, six were benign and 14 were inconclusive. Non-Hodgkin lymphoma was identified in 22 cases. Metastatic poorly differentiated carcinoma was diagnosed in 11 cases, while tuberculous lymphadenitis was identified in five cases.

All 33 diagnostically classified gastrointestinal malignancies included 31 adenocarcinomas, one malignant gastrointestinal stromal tumour and one leiomyosarcoma. Thirteen gastrointestinal aspirates were inconclusive.Table 4. Major organ-specific cytological findings

Organ or site	**Total cases**	**Broad cytological distribution**	**Leading specific diagnoses**
Liver	307	Benign 56; malignant 160; inconclusive 91	Metastases 83; hepatocellular carcinoma 54; pyogenic abscess 31; tuberculous abscess 8
Spleen	25	Benign 16; malignant 6; inconclusive 3	Pyogenic abscess, granulomatous inflammation, lymphoma and metastatic carcinoma
Pancreas	13	Benign 1; malignant 9; inconclusive 3	Adenocarcinoma 8; solid pseudopapillary epithelial neoplasm 1
Kidney	60	Benign 12; malignant 29; inconclusive 19	Renal cell carcinoma 14; Wilms tumour 6

Adrenal gland	9	Benign 1; malignant 7; inconclusive 1	Neuroblastoma 5; pheochromocytoma 1
Ovary	52	Benign 12; malignant 19; inconclusive 21	Papillary adenocarcinoma 14; serous cystadenoma 8; mature cystic teratoma 3
Retroperitoneal lymph nodes	70	Benign 6; malignant 50; inconclusive 14	Non-Hodgkin lymphoma 22; metastatic poorly differentiated carcinoma 11; tuberculous lymphadenitis 5
Gastrointestinal tract	46	Malignant 33; inconclusive 13	Adenocarcinoma 31; malignant gastrointestinal stromal tumour 1; leiomyosarcoma 1

Histopathological follow-up was available in 58 of the 660 cases. Among these, 34 cases were true positive and 16 were true negative. Two cases were false positive, while six were false negative. Thus, histopathological examination confirmed malignancy in 40 cases and benign or non-neoplastic disease in 18 cases.

Table 5. Comparison of cytological and histopathological diagnoses

Cytological interpretation	Histopathologically malignant	Histopathologically benign or non-neoplastic	Total
Malignant or positive for malignancy	34, true positive	2, false positive	36
Benign, negative or inconclusive	6, false negative	16, true negative	22
Total	**40**	**18**	**58**

Based on the 58 cases with histopathological follow-up, image-guided FNAC showed a sensitivity of 85.0% and a specificity of 88.9% for the detection of malignancy. The positive predictive value was 94.4%, indicating a high probability that a cytologically malignant diagnosis represented true malignancy on histopathology.

The negative predictive value was 72.7%, while the overall diagnostic accuracy was 86.2%. No inferential statistical tests were performed because the analysis was primarily descriptive and histopathological verification was available only in a subset of the study population.

Table 6. Diagnostic performance of image-guided FNAC

Diagnostic parameter	Calculation	Value
Sensitivity	34/(34+6) × 100	85.0%
Specificity	16/(16+2) × 100	88.9%
Positive predictive value	34/(34+2) × 100	94.4%
Negative predictive value	16/(16+6) × 100	72.7%
Overall diagnostic accuracy	(34+16)/58 × 100	86.2%

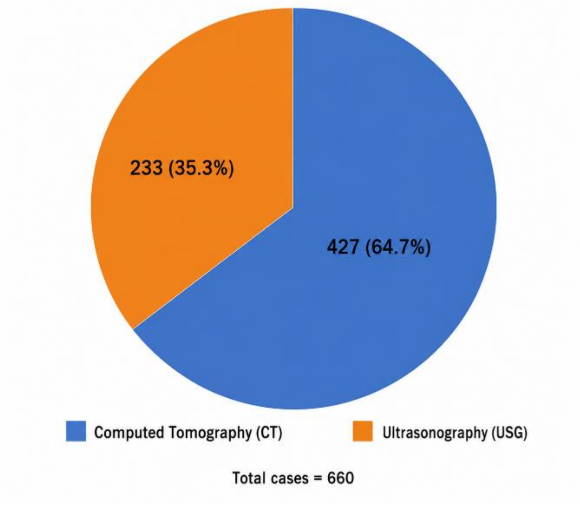

Figure 1. Distribution of image-guided FNAC procedures according to the radiological guidance modality

Figure 1 shows the distribution of the 660 image-guided FNAC procedures according to the radiological guidance modality used. Computed tomography was the most commonly used technique, guiding 427 procedures (64.7%), whereas ultrasonography was used in 233 procedures (35.3%). Thus, nearly two-thirds of the intra-abdominal lesions were aspirated under CT guidance. This predominance may reflect the frequent occurrence of deep-seated, small or anatomically difficult lesions that required precise localisation and a clearly defined needle pathway. Ultrasonography remained an important guidance method for lesions that were easily visualised and accessible through real-time imaging.

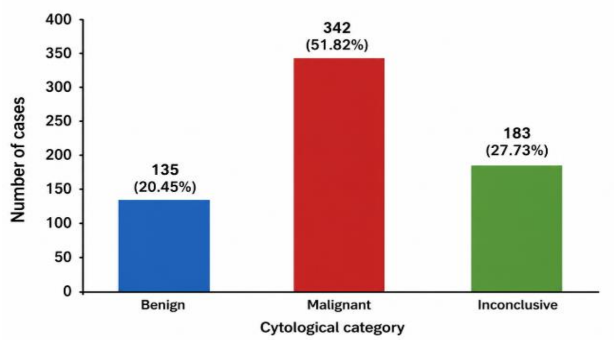

Figure 2. Distribution of intra-abdominal lesions according to the overall cytological category

Figure 2 shows the overall cytological classification of 660 intra-abdominal lesions evaluated by image-guided FNAC. Malignant lesions formed the largest category, comprising 342 cases (51.82%). Inconclusive lesions accounted for 183 cases (27.73%), including inadequate aspirates and cases showing atypical cells in which malignancy could not be excluded. Benign lesions represented 135 cases (20.45%). Thus, more than half of the intra-abdominal lesions were cytologically malignant, while nearly one-quarter of the specimens were inadequate or inconclusive.

DISCUSSION

The present eight-year study evaluated 660 image-guided fine-needle aspiration cytology procedures performed for intra-abdominal lesions. The main findings were a predominance of male patients, concentration of cases in the fifth to seventh decades, frequent use of computed tomography guidance, predominance of hepatobiliary lesions and a higher proportion of malignant than benign lesions. Histopathological follow-up in 58 cases showed good diagnostic performance, with particularly high positive predictive value. These findings support the practical role of image-guided FNAC in the initial evaluation of deep-seated intra-abdominal lesions.

Male patients constituted 59.39% of the study population, producing a male-to-female ratio of approximately 1.46:1. The largest proportion of cases occurred between 51 and 60 years, and more than three-fifths of the patients were between 41 and 70 years. This age pattern is understandable because many primary and metastatic intra-abdominal malignancies become clinically or radiologically apparent during middle and older age. Baisakh et al. also observed male predominance and a concentration of abdominopelvic lesions in middle-aged and older patients undergoing ultrasound-guided FNAC [9]. However, differences in age and sex distribution between studies may reflect regional disease patterns, referral practices and the types of organs included.

Computed tomography was used to guide 427 procedures (64.7%), whereas ultrasonography guided 233 procedures (35.3%). The predominance of CT guidance may be related to the large number of deep-seated hepatic, retroperitoneal, renal and gastrointestinal lesions included in the study. CT allows clear visualisation of the lesion, surrounding organs and the proposed needle pathway. However, the reasons for selecting CT or ultrasonography were not separately recorded; therefore, this explanation remains an interpretation rather than a directly tested finding. Ultrasonography remains useful for lesions that can be visualised in real time and accessed without interference from bowel gas or overlying bone. Islam et al. reported that ultrasound-guided FNAC was a sensitive diagnostic procedure for a broad range of intra-abdominal neoplastic and non-neoplastic lesions [10].

The hepatobiliary system was the most frequently aspirated anatomical group, accounting for 313 cases (47.42%), of which 307 involved the liver. This predominance is expected because the liver is commonly affected by primary tumours, metastatic deposits, abscesses and other focal lesions. It is also comparatively accessible to percutaneous aspiration. Among the hepatic lesions, 160 were malignant, 56 were benign and 91 were inconclusive. Metastatic malignancies were the largest specific malignant group, with 83 cases, followed by hepatocellular carcinoma with 54 cases. The predominance of metastases is biologically reasonable because the liver receives blood from both the portal and systemic circulation and is a common site for the spread of malignancies arising in the gastrointestinal tract, pancreas, lung, breast and other organs.

In the study by Swamy et al., neoplastic lesions also formed the major proportion of ultrasound-guided hepatic aspirates, although hepatocellular carcinoma was more frequent than metastatic adenocarcinoma [11]. The difference from the present study may be due to variations in referral populations, underlying liver disease, cancer prevalence and the proportion of patients with known extrahepatic malignancies. Swamy et al. also reported high sensitivity, specificity and diagnostic accuracy for ultrasound-guided FNAC of hepatic lesions, supporting its value in distinguishing primary hepatic malignancy from metastatic disease [11].

Non-neoplastic hepatic lesions were also well represented. Pyogenic abscess was the most frequent benign hepatic diagnosis, followed by tuberculous abscess, amoebic abscess, cystic lesions, granulomatous inflammation, cirrhosis and focal nodular hyperplasia. These findings show that image-guided FNAC is not limited to the diagnosis of malignancy. It can also provide material for identifying inflammatory and infective lesions, which may considerably change patient management. Nevertheless, reactive hepatocytes, necrosis and inflammatory atypia can sometimes mimic malignancy, while highly necrotic tumours may yield insufficient viable cells. Clinical and radiological correlation is therefore essential when interpreting hepatic aspirates.

Splenic lesions represented 25 cases, of which 16 were benign, six were malignant and three were inconclusive. Benign inflammatory and infective lesions predominated, while lymphoma and metastatic carcinoma formed the main malignant groups. Splenic aspiration has historically been used cautiously because of the possibility of haemorrhage. However, image guidance, fine-gauge needles and careful selection of the needle pathway have improved its safety and clinical usefulness. A multicentre study by Civardi et al. demonstrated that ultrasound-guided fine-needle biopsy of the spleen could provide useful diagnostic information with a low risk of major complications [12]. The present findings similarly indicate that splenic FNAC may help distinguish abscesses and granulomatous inflammation from lymphoma or metastatic disease when less invasive investigations are inconclusive.

Malignant lesions constituted nine of the 13 pancreatic aspirates, with adenocarcinoma accounting for eight cases. One solid pseudopapillary epithelial neoplasm and one granulomatous lesion were also diagnosed, while three aspirates were inconclusive. The predominance of adenocarcinoma is consistent with the usual spectrum of solid pancreatic malignancy. However, pancreatic FNAC can be difficult because of the deep location of the organ, surrounding vascular and gastrointestinal structures, tumour desmoplasia and the presence of necrotic or inflammatory material. Cherian et al. reported high diagnostic accuracy for endoscopic ultrasound-guided aspiration of solid pancreatic and peripancreatic lesions [13].

The value of immediate assessment of pancreatic aspirates has also been demonstrated. In a meta-analysis, Hébert-Magee et al. reported pooled sensitivity and specificity of 88.6% and 99.3%, respectively, for endoscopic ultrasound-guided FNAC of pancreatic ductal adenocarcinoma. Rapid on-site cytological evaluation was associated with improved diagnostic accuracy [14]. Although rapid on-site evaluation was not documented in the present study, its future use could help determine specimen adequacy during the procedure and reduce the need for repeat aspiration, particularly in pancreatic and other technically challenging lesions.

Renal lesions accounted for 60 cases, including 12 benign, 29 malignant and 19 inconclusive aspirates. Renal cell carcinoma was the most frequent specifically typed renal malignancy, followed by Wilms tumour. The benign spectrum included renal oncocytoma, cysts, pyogenic and tuberculous abscesses, inflammatory lesions and xanthogranulomatous pyelonephritis. Mondal and Ghosh reported that FNAC could provide reliable preoperative diagnosis in solid renal masses, with an accuracy of approximately 91% in their series [15]. The present findings confirm that renal FNAC can identify common primary malignancies and inflammatory conditions. However, the relatively high number of inconclusive renal aspirates suggests that cystic change, necrosis, haemorrhage or sampling of non-representative areas may limit interpretation. These possible causes were not individually analysed in the thesis and should therefore be considered cautiously.

The adrenal gland was an uncommon aspiration site, with nine cases. Neuroblastoma was the most frequent malignant diagnosis and occurred predominantly in children, while one pheochromocytoma was reported among the benign neoplasms. Adrenal FNAC requires careful clinical and radiological assessment because unsuspected pheochromocytoma may create a risk of catecholamine-related complications. Moreover, cytological distinction between primary adrenal tumours and metastatic malignancies can be difficult without clinical history, radiological findings and ancillary testing.

Retroperitoneal lesions formed the second-largest anatomical group, accounting for 102 cases. Among 70 retroperitoneal lymph-node aspirates, 50 were malignant, six were benign and 14 were inconclusive. Non-Hodgkin lymphoma was the most frequent primary malignant lymphoid lesion, while poorly differentiated carcinoma was the leading metastatic diagnosis. Tuberculous lymphadenitis was the most frequent benign condition. Gangopadhyay et al. similarly demonstrated that image-guided FNAC could identify primary and metastatic retroperitoneal tumours and assist in determining the likely line of management [16].

Mangal et al. reported malignant lesions in 47 of 85 retroperitoneal masses. Their study also found renal cell carcinoma and Wilms tumour to be common renal lesions, while metastatic carcinoma, non-Hodgkin lymphoma and tuberculosis were prominent diagnoses in retroperitoneal lymph nodes [17]. This pattern is comparable with the present findings. In their study, cytological and histopathological diagnoses were concordant in 45 of 47 correlated cases, demonstrating the value of guided aspiration in this anatomically difficult region [17].

Among the 32 non-nodal retroperitoneal masses in the present study, sarcomas formed an important malignant group. These included spindle-cell sarcoma, liposarcoma, malignant pleomorphic sarcoma and neurogenic sarcoma. Precise subclassification of sarcomas on cytological material may be difficult because many tumours share overlapping spindle-cell or pleomorphic features. Cell-block preparation, immunocytochemistry and molecular testing are therefore valuable when adequate material is available. A cytological diagnosis of "malignant spindle-cell neoplasm" or "sarcoma" may be more appropriate than an overly specific diagnosis when characteristic features and ancillary confirmation are absent.

Female genital tract lesions accounted for 65 cases, including 52 ovarian and 13 uterine lesions. Of the ovarian lesions, 19 were malignant, 12 were benign and 21 were inconclusive. Papillary adenocarcinoma was the most frequent malignant ovarian diagnosis, while serous cystadenoma was the leading benign lesion. Sood et al. reported high sensitivity, specificity and overall accuracy for aspiration cytology of ovarian masses when adequate material and histopathological correlation were available [18]. Nevertheless, ovarian aspiration must be used selectively because of concerns about sampling errors, cystic lesions and possible tumour spillage in lesions suspected to represent early-stage primary ovarian malignancy.

Bandyopadhyay et al. also found FNAC useful in distinguishing benign from malignant ovarian tumours, although a proportion of aspirates remained inconclusive [19]. The high inconclusive proportion in the present ovarian group, 21 of 52 cases, may be related to the predominantly cystic nature of some ovarian lesions, limited epithelial cellularity, necrosis or sampling from a non-representative area. However, individual reasons for ovarian inadequacy were not documented and cannot be confirmed from the available data. Among uterine lesions, leiomyoma was the dominant diagnosis, indicating that image-guided aspiration can also provide useful information in selected uterine masses.

Gastrointestinal tract lesions accounted for 46 aspirates. Thirty-three were malignant, including 31 adenocarcinomas, one malignant gastrointestinal stromal tumour and one leiomyosarcoma. Thirteen were inconclusive. The predominance of adenocarcinoma is consistent with the epithelial origin of most gastrointestinal malignancies. However, gastrointestinal lesions may be difficult to aspirate because of bowel movement, luminal gas, tumour necrosis and the risk of sampling adjacent inflammatory or fibrotic tissue. For suspected mesenchymal lesions, cytomorphology alone may not reliably distinguish gastrointestinal stromal tumour from other spindle-cell neoplasms. Immunocytochemical markers applied to cell-block material are therefore important for definitive classification.

Overall, malignant lesions accounted for 342 cases (51.82%), compared with 135 benign lesions (20.45%). This predominance probably reflects the tertiary-care setting, where patients with radiologically suspicious, advanced or inaccessible lesions are more likely to be referred for image-guided aspiration. A similar predominance of malignant intra-abdominal lesions has been reported in other institutional studies, although the exact proportion varies according to case selection and anatomical distribution [9,10]. The high malignant yield illustrates the clinical importance of FNAC in providing a rapid diagnosis that may permit initiation of oncological treatment without exploratory surgery in appropriately selected patients.

Histopathological correlation was available in 58 cases. Based on 34 true-positive, 16 true-negative, two false-positive and six false-negative results, image-guided FNAC achieved a sensitivity of 85.0%, specificity of 88.9%, positive predictive value of 94.4%, negative predictive value of 72.7% and overall accuracy of 86.2%. These results are broadly comparable with the diagnostic performance reported in other studies of image-guided abdominal FNAC [9,10]. The high positive predictive value indicates that a malignant cytological diagnosis was highly likely to be confirmed histologically. In contrast, the lower negative predictive value shows that a benign, negative or inconclusive aspirate did not reliably exclude malignancy. Such cases require careful radiological correlation and repeat FNAC, core biopsy or surgical biopsy when clinical suspicion remains high.

Only 58 of 660 cases had histopathological follow-up. Consequently, the diagnostic performance estimates were derived from a selected subgroup rather than the entire population. Patients undergoing surgical biopsy or excision may differ from those managed clinically without histological confirmation, creating the possibility of partial verification bias. In addition, inconclusive cases classified as false negative may include specimens that were technically inadequate rather than cytologically interpreted as definitely benign. These factors should be considered when comparing the accuracy values with other studies.

Inconclusive diagnoses accounted for 183 cases (27.73%), including 157 inadequate aspirates and 26 specimens showing atypical cells in which malignancy could not be excluded. The inadequate-sampling rate of 23.79% is clinically important. Possible contributing factors include small or deep lesions, cystic change, haemorrhage, fibrosis, extensive necrosis and inaccurate targeting of viable tumour areas. However, the study did not record the cause of inadequacy, number of passes or lesion size, preventing formal evaluation of these factors.

The use of rapid on-site evaluation, additional targeted passes, cell-block preparation and immunocytochemistry may improve diagnostic yield. Bhowmik et al. found that cell blocks were more specific than conventional cytological smears and that combining FNAC with cell-block examination improved the diagnosis of intra-abdominal masses [20]. Cell blocks also permit assessment of limited architectural features and provide material for immunocytochemistry. These methods would be particularly valuable for poorly differentiated malignancies, lymphomas, metastatic tumours, spindle-cell neoplasms and lesions reported only as positive for malignancy.

The major strength of the present study is its large sample of 660 cases collected over eight years and its inclusion of lesions from a broad range of intra-abdominal organs. It provides useful information regarding the anatomical and cytological spectrum encountered in a tertiary-care centre. The study also demonstrates the practical application of both ultrasonography and CT guidance.

The study has several limitations. Histopathological follow-up was available for only a small proportion of cases. The retrospective component may have been affected by incomplete clinical and procedural documentation. Organ-specific adequacy criteria were not predefined, and the number of needle passes, lesion dimensions, use of rapid on-site evaluation and reasons for inadequate sampling were not recorded. Cell blocks, immunocytochemistry and molecular tests were not routinely documented. In addition, no inferential analysis was performed to identify factors associated with malignancy, inadequate sampling or diagnostic disagreement.

Despite these limitations, the findings demonstrate that image-guided FNAC is a valuable method for evaluating intra-abdominal lesions. It provided diagnoses across a wide spectrum of benign, inflammatory, primary malignant and metastatic conditions and achieved good agreement with histopathology in the correlated cases. Its high positive predictive value supports treatment planning after a clearly malignant result. Nevertheless, negative and inconclusive findings should be interpreted cautiously. Improved lesion targeting, rapid on-site adequacy assessment, cell-block preparation and appropriate ancillary testing may further reduce non-diagnostic aspirates and improve tumour classification.

CONCLUSION

Image-guided fine-needle aspiration cytology was found to be a useful, minimally invasive and reliable method for evaluating intra-abdominal lesions. In this eight-year study of 660 cases, computed tomography was used more frequently than ultrasonography for guidance, and the hepatobiliary system, particularly the liver, was the most commonly aspirated site. Malignant lesions formed the largest cytological category, accounting for 51.82% of all cases, while benign and inconclusive lesions accounted for 20.45% and 27.73%, respectively. The procedure identified a broad spectrum of primary malignancies, metastatic tumours, benign neoplasms and inflammatory or infective lesions.

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