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Original Research Article

Cytological Evaluation of Body Fluids: Diagnostic Role and Patterns in a Tertiary Care Centre of North Bihar

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Abstract:

Background: Fluid cytology plays a pivotal role in the evaluation of serous effusions and other body fluids. It offers a minimally invasive, cost-effective, and rapid diagnostic tool for identifying a wide spectrum of benign and malignant conditions. Despite being a vital part of diagnostic pathology, the utility and diagnostic spectrum of cytological examination in body fluids remain underexplored in certain regional healthcare settings, such as Bihar.

Objective: To assess the diagnostic utility, spectrum of cytological findings, and the distribution of benign versus malignant cases in various body fluids (pleural, peritoneal, and cerebrospinal fluid) over a one-year period at a tertiary care hospital in Bihar.

Materials and Methods: A retrospective study was conducted in the Department of Pathology, Darbhanga Medical College and Hospital, Darbhanga, Bihar, over a period of 12 months (August 2024 to July 2025). A total of 125 fluid samples were included, comprising pleural, peritoneal, and cerebrospinal fluids received in the cytology section. All samples were processed using standard centrifugation, smear preparation, and staining techniques (Papanicolaou, Giemsa, and H&E where needed). Cytological findings were categorized into benign, suspicious, and malignant categories.

Results: Out of the 125 fluid samples analyzed, 102 (81.6%) were diagnosed as benign/reactive, 13 (10.4%) were malignant, and 10 (8%) were suspicious for malignancy. Among malignant cases, adenocarcinoma was the most frequently identified malignancy, predominantly involving pleural fluid. The diagnostic yield was highest for pleural effusions, followed by ascitic and cerebrospinal fluids. Cytological examination provided significant diagnostic clues in cases of suspected malignancy and infection, thus aiding in clinical decision-making.

Conclusion: Fluid cytology is an indispensable diagnostic modality in the assessment of body fluids. Its non-invasive nature, combined with reasonable accuracy, makes it a valuable first-line investigation. In resource-constrained settings like Bihar, it proves to be both practical and cost-effective, especially in early detection of malignancies and infectious diseases.

Keywords: Fluid Cytology, Pleural Effusion, Peritoneal Fluid, Malignancy, Body Fluids, Diagnostic Cytopathology, Tertiary Care.

Introduction

Cytological examination of body fluids, also known as exfoliative cytology, has emerged as a vital diagnostic tool in clinical pathology. It enables the evaluation of cells shed into serous cavities pleural, peritoneal (ascitic), pericardial, and cerebrospinal fluids for diagnostic, prognostic, and sometimes therapeutic guidance. These fluid samples, often collected through minimally invasive techniques such as thoracentesis, paracentesis, or lumbar puncture, offer an opportunity to investigate underlying pathological processes without resorting to more aggressive diagnostic modalities [1].

Effusions may occur due to a wide array of pathological conditions, broadly categorized into transudates and exudates. While transudates are usually secondary to systemic conditions like congestive

heart failure, cirrhosis, or nephrotic syndrome, exudates are more commonly associated with infections, malignancies, autoimmune disorders, and organ-specific diseases [2]. Among these, the detection of malignant cells in effusions is of paramount importance, especially in settings where imaging and histopathology resources may be limited or delayed. Malignant effusions may arise from primary neoplasms of the lung, breast, gastrointestinal tract, or ovary, or due to metastatic dissemination, and their presence often indicates advanced-stage disease with prognostic implications [3].

Infection-related effusions also contribute significantly to cytology workloads, particularly in developing countries like India, where tuberculosis remains endemic. The presence of granulomatous inflammation, reactive mesothelial changes, or features suggestive of bacterial or fungal infections may be seen in such cases. Moreover, autoimmune diseases such as systemic lupus erythematosus (SLE) may also present with characteristic cytological features, making fluid cytology a versatile diagnostic approach [4].

Despite its wide utility, fluid cytology remains underutilized or inconsistently practiced in several regions due to variable levels of expertise, inadequate sample handling, or lack of standardization in smear preparation and staining protocols [5]. The diagnostic yield from fluid cytology depends on several pre-analytical and analytical factors: volume of fluid collected, centrifugation technique, staining quality, and experience of the cytopathologist. Ancillary techniques such as cell block preparation, immunocytochemistry, and molecular diagnostics have improved sensitivity and specificity, but such resources are often unavailable in peripheral or under-resourced medical centers [6].

In Bihar, one of India's most populous and medically underserved states, access to advanced diagnostic facilities is often limited to Darbhanga Medical College and Hospital, being one of the oldest and most prominent government-run teaching hospitals in the region, receives a wide spectrum of cases from across North Bihar. The cytology section of the pathology department caters to routine diagnostic evaluation of body fluids referred from both inpatient and outpatient departments, offering a rich source of epidemiological and diagnostic data [7].

Despite the clinical importance of fluid cytology, there is a paucity of published regional data from tertiary care hospitals in Bihar. Given the unique demographic, socioeconomic, and disease burden profile of the population, there is a compelling need to study the cytological patterns seen in this region. This study attempts to bridge that gap by evaluating the diagnostic utility of cytological examination of body fluids, with an emphasis on classifying benign, suspicious, and malignant cases, and correlating them with the type of fluid, patient demographics, and clinical context [8].

By analyzing 125 fluid samples collected over a 12-month period, this study aims to generate practical insights into the diagnostic yield and spectrum of cytological findings. It highlights the importance of integrating fluid cytology into the routine diagnostic pathway, especially in resource-constrained settings, where it can serve as a valuable frontline tool for clinicians to initiate timely and appropriate management.

Materials and Methods

Study Design and Setting: A retrospective study conducted in the Department of Pathology, Darbhanga Medical College and Hospital (DMCH), Laheriasarai, Darbhanga, Bihar. The study was carried out over a duration of 12 months, from August 2024 to July 2025

Study Population and Sample Size: A total of 125 body fluid samples were included in the study. The sample size was determined based on the average annual sample load and expected prevalence of diagnostic categories observed in prior internal audits. All fluid specimens were collected from patients admitted to various inpatient departments, as well as from selected outpatient referrals, based on clinical indications for cytological examination.

Inclusion Criteria

- All patients of any age group and gender presenting with clinically significant effusions and referred for cytological analysis.
- Samples that had adequate volume (minimum 10 mL for pleural and peritoneal fluids; minimum 2–3 mL for cerebrospinal fluid).
- Samples that were transported to the pathology laboratory within 2 hours of collection to ensure optimal preservation of cellular morphology.

Exclusion Criteria

- Samples with insufficient volume or gross hemolysis/clotting.
- Repeated fluid specimens from the same patient unless clinically justified (e.g., monitoring malignancy or infection).
- Samples without accompanying clinical data or relevant requisition forms necessary for cytological interpretation.

Sample Collection and Handling: All body fluids were collected aseptically by the respective clinical units using standard techniques: pleural and ascitic fluids via thoracentesis or paracentesis, and cerebrospinal fluid via lumbar puncture. The collected samples were placed in sterile, properly labeled containers and promptly transported to the cytology laboratory for processing.

Upon receipt, samples were visually inspected and then subjected to centrifugation at 2500 revolutions per minute for 15 minutes. The sediment obtained was used for preparation of smears. Where adequate sediment was available, cell block preparation was undertaken to enhance morphological assessment and allow for ancillary tests in select cases.

Staining Protocol: The prepared smears were subjected to multiple staining techniques for comprehensive cytological evaluation. These included:

- Giemsa stain for overall cytomorphology, background assessment, and inflammatory cell details.
- Papanicolaou (Pap) stain to examine nuclear features and cytoplasmic details, especially for detecting atypical and malignant cells.
- Hematoxylin and Eosin (H&E) stain in cases where a cell block was prepared, allowing histological correlation in suspicious or malignant effusions.

All stained slides were examined under light microscopy by two independent cytopathologists to minimize observer bias and improve diagnostic reliability.

Cytological Classification: Based on established cytomorphological criteria and consensus review, the smears were classified into the following diagnostic categories:

1. Benign or reactive effusions – including inflammatory (acute or chronic), infectious (e.g., tubercular), and reactive mesothelial changes.
2. Suspicious for malignancy – cases showing atypical features such as nuclear enlargement, hyperchromasia, and increased nuclear-cytoplasmic ratio, but lacking definitive malignant architecture.
3. Malignant effusions – clear presence of malignant cells with diagnostic features consistent with adenocarcinoma, squamous cell carcinoma, or other specific histological types.

Where applicable, clinical details such as history of known malignancy, imaging findings, or tumor markers were taken into account during interpretation.

Data Collection and Statistical Analysis: Patient demographic details (age, sex), type of effusion, clinical diagnosis, and cytological findings were systematically recorded. Data were compiled and tabulated using Microsoft Excel. Descriptive statistical analysis was conducted to calculate frequencies, percentages, and diagnostic yield across fluid types and diagnostic categories. The proportion of benign, suspicious, and malignant effusions was compared, and findings were evaluated in relation to the type of fluid and suspected clinical condition.

Results

A total of 125 fluid samples were evaluated cytologically over the one-year study period. Pleural and peritoneal fluids comprised the majority of the cases, with a smaller proportion of cerebrospinal fluids. The study population showed a male predominance, with most patients in the 41–70 year age range. Cytological examination revealed that 81.6% of the effusions were benign/reactive, while 10.4% were malignant and 8% were categorized as suspicious. Malignancy was most frequently detected in pleural fluid specimens. Adenocarcinoma was the most common malignancy encountered. Cell block technique enhanced diagnostic yield in selected malignant cases. Among benign effusions, tuberculosis, liver disease, and cardiac failure were the leading causes.

Table 1: Distribution of Samples by Type of Fluid

Type of Fluid	Number of Cases	Percentage (%)
Pleural Fluid	60	48.0
Peritoneal (Ascitic) Fluid	50	40.0
Cerebrospinal Fluid (CSF)	15	12.0

Table 2: Gender Distribution of Patients

Gender	Number of Cases	Percentage (%)
Male	71	56.8
Female	54	43.2

Table 3: Age Distribution of Patients

Age Group (Years)	Number of Cases	Percentage (%)
<20	8	6.4
21–40	25	20.0
41–60	56	44.8
61–80	36	28.8

Table 4: Overall Cytological Diagnosis

Diagnosis Category	Number of Cases	Percentage (%)

Benign / Reactive	102	81.6
Suspicious for Malignancy	10	8.0
Malignant	13	10.4

Table 5: Malignant Effusions by Fluid Type

Type of Fluid	Malignant Cases	Percentage of Malignant Cases (%)
Pleural Fluid	8	61.5
Peritoneal Fluid	4	30.7
CSF	1	7.8

Table 6: Distribution of Malignancy Types

Type of Malignancy	Number of Cases	Percentage (%)
Adenocarcinoma	10	76.9
Squamous Cell Carcinoma	1	7.7
Poorly Differentiated Carcinoma	2	15.4

Table 7: Cytological Categories by Fluid Type

Fluid Type	Benign	Suspicious	Malignant
Pleural	48	4	8
Peritoneal	41	5	4
CSF	13	1	1

Table 8: Clinical Diagnosis Among Benign Effusions

Benign Etiology	Number of Cases	Percentage (%)
Tuberculosis	26	20.8
Congestive Heart Failure	12	9.6
Pancreatitis	6	4.8
Others	41	32.8

Table 9: Use of Cell Block Technique in Malignant Cases

Malignant Cases (n=30)	Number of Cases	Diagnostic Yield Enhanced
With Cell Block	8	Yes

Table 10: Suspicious Cases and Follow-up Recommendation

Feature	Number of Cases
Atypical Cytology Present	10
Clinical Follow-up Recommended	10
Cell Block Study	10

Table 1 summarized the types of fluids analyzed, with pleural fluid being the most common. Table 2 presented the gender distribution, revealing a male predominance. Table 3 showed that most cases were in the 41–60 year age group. Table 4 classified cases into benign, suspicious, and malignant, with benign being most frequent. Table 5 revealed that pleural fluid had the highest number of malignant cases. Table 6 identified adenocarcinoma as the most common malignancy. Table 7 correlated fluid types with cytological categories, confirming malignancy predominance in pleural fluid. Table 8 described the common causes of benign effusions, notably tuberculosis and liver disease. Table 9 demonstrated that 8 (out of 13 Malegnant cases) ambiguous cases undergone cell block study and dignostic yield enhanced. Table 10 In 10 Atypical Cytology cases, clinical follow up recommended and 2 also undergone cell block study.

Discussion

The present study underscores the diagnostic relevance of cytological analysis of body cavity fluids pleural, peritoneal, and cerebrospinal in identifying both malignant and non-malignant conditions. Fluid cytology remains a vital, non-invasive, and cost-effective first-line investigation, especially in settings with limited access to advanced diagnostic modalities [9]. Our 12-month study, conducted at a tertiary care teaching hospital in Bihar, included 125 fluid specimens and demonstrated a substantial diagnostic yield, particularly for malignant effusions.

A significant proportion of the cases in our study were benign/reactive (81.6%), consistent with global literature where benign effusions dominate, especially in tuberculosis-endemic and resource-limited regions. Tuberculosis was the leading benign etiology in our cohort (20.8%), which aligns with

epidemiological data from northern and eastern India. Other common benign causes identified were liver cirrhosis and congestive heart failure, reinforcing the fact that effusions are frequently secondary to chronic systemic illnesses. These findings also reflect the regional disease burden and the demographic profile of patients visiting government hospitals [10].

Malignant effusions accounted for 10.4% of the cases in our study, a finding that supports previous observations in the literature that the rate of malignancy in effusions can range between 10% and 30%. Pleural fluids were more likely to be malignant compared to peritoneal or cerebrospinal fluids. Among the malignant cases, adenocarcinoma was the most commonly encountered histological type (76.9%), a trend similarly reported in several Indian and international studies. This is likely due to the propensity of adenocarcinomas from primary sites such as the lung, breast, and gastrointestinal tract to spread via serosal surfaces [11].

Interestingly, 8% of the cases were labeled as "suspicious for malignancy," reflecting a diagnostic gray zone in fluid cytology. These cases often showed atypical or degenerated cells, inadequate cellularity, or obscuring inflammation, necessitating further investigations like biopsy, immunocytochemistry, or radiological correlation. All suspicious cases in our study were advised for clinical follow-up or cell block study and this diagnostic caution is vital to avoid both over- and under-diagnosis [12].

An important adjunct in our protocol was the use of the cell block technique, applied in 8 of the malignant cases. This method helped enhance architectural preservation and allowed more definitive diagnosis, especially in morphologically ambiguous cases. The diagnostic utility of cell blocks is well recognized, and its use in effusion cytology has shown to improve sensitivity and allow ancillary testing, including immunohistochemistry. Although not employed universally across all samples due to logistical constraints, cell block preparation demonstrated improved cellular yield and diagnostic clarity in our study, corroborating findings from other Indian cytology studies [13].

The male predominance seen in our study (56.8%) could be attributed to higher smoking prevalence, occupational exposures, and delayed health-seeking behavior among males in rural and semi-urban Bihar. The age distribution peaking between 41 and 70 years is consistent with age-related incidence patterns of both malignancies and chronic inflammatory diseases. It also highlights the need for increased screening and early diagnostic facilities for this age group in high-burden settings [14].

Overall, our study reaffirms the significant diagnostic value of fluid cytology in evaluating both benign and malignant effusions. While it cannot substitute histopathology in all instances, its utility as a screening and triaging tool remains unmatched—particularly in low-resource settings where imaging or surgical biopsy may not be readily available. The method is minimally invasive, quick, cost-effective, and offers a high yield when combined with proper sampling, staining, and, where available, cell block preparation [15].

The limitations of our study include its single-center design, a modest sample size, and lack of histopathological correlation in all malignant cases. Also, advanced techniques such as immunocytochemistry or molecular diagnostics were not uniformly employed. Despite these constraints, the study adds valuable data to the existing body of evidence supporting fluid cytology as a frontline diagnostic tool.

Fluid cytology, when appropriately applied and interpreted, continues to play a pivotal role in the timely diagnosis of effusions. It not only aids in identifying malignancy but also directs further clinical management in benign conditions. Continued training, adoption of cell block techniques, and incorporation of ancillary studies can further enhance its diagnostic performance in tertiary care settings across India.

Conclusion

The cytological evaluation of body cavity fluids remains a cornerstone in the diagnostic approach to effusions. In this hospital-based study from Bihar, fluid cytology demonstrated significant diagnostic utility in distinguishing benign, suspicious, and malignant conditions. A majority of effusions were benign/reactive in nature, with tuberculosis and chronic systemic diseases being predominant causes. Malignant effusions comprised a substantial proportion, with pleural fluid being the most frequent site and adenocarcinoma the most common malignancy identified. The application of the cell block technique in selected cases enhanced diagnostic clarity, emphasizing its role as an important adjunct to conventional smears. The study further highlights the relevance of fluid cytology in resource-limited settings, offering a rapid, safe, and cost-effective method for early diagnosis and guiding patient management. Continued emphasis on cytological expertise, standardization of reporting, and integration with ancillary techniques can further augment its diagnostic potential.

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