International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

A Comparative Study of Conventional Cytosmear and Cell Block Techniques in the Diagnosis of Serous Effusions

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Received: 25-05-2026
Accepted: 10-06-2026
Available online: 22-06-2026

ABSTRACT

Introduction: Serous effusions involving peritoneal, pleural or pericardial cavities are frequently encountered in clinical practice. These effusions arise from a disruption of Starling's forces due to various inflammatory, infectious or neoplastic conditions. While conventional cytosmear remains the standard diagnostic tool but has limitations such as cellular overlap, poor architectural preservation, limited sensitivity in differentiating reactive mesothelial cells from malignant cells.
Objective: To compare the diagnostic efficacy of conventional cytosmears (CS) versus the cell block technique (CB) in serous effusions focusing on the detection of malignancies.
Material & Methods: This hospital-based cross-sectional study was conducted on 103 serous effusions (72 pleural, 31 ascitic) at Pathology Department of tertiary health-care centre. Samples were processed using both conventional centrifugation and the plasma-thromboplastin cell block method. Quality was assessed using Mair's criteria.
Observations: The study showed male predominance (65.05%) with peak incidence in the 41–50 age group. The CB method was found to be statistically superior to CS in all morphological parameters (P <0.0001), providing higher cellularity and better architectural preservation. The CB technique resolved 100% of cases categorized as "suspicious for malignancy" on CS (P = 0.0016), reclassifying them into definitive benign or malignant categories. Overall malignancy detection increased from 1.94% (CS) to 4.85% (CB).
Conclusion: The cell block technique significantly enhances diagnostic accuracy by acting as a "mini-biopsy" that preserves tissue architecture. It bridges the gap between cytology and histology, effectively eliminating diagnostic ambiguity in "suspicious" cases and facilitating better patient management.

Keywords: *Serous Effusions, Conventional Cytosmear, Cell Block Technique.*

INTRODUCTION

Serous effusions imply that accumulation of fluid is in excess of the normal expected amount in the serous cavities.[1] Accumulation of fluid other than blood in the body cavities is broadly described as 'effusion'.[2] The transudates are clear, straw-coloured fluids that do not clot and have low specific gravity (<1.010) and low protein content (<3 g/dl). The exudates are turbid or cloudy and have relatively high protein content (>3 g/dl) and high specific gravity (>1.015).[3]

The pathophysiology of serous effusion is governed by the disruption of Starling's forces, which normally maintain a dynamic equilibrium between the capillary bed and the interstitial space.[4] In malignant effusions, a combination of these factors is often present, as tumor cells not only block lymphatic outlets but also secrete vascular endothelial growth factors (VEGF) that significantly enhance vascular leakiness.[5]

Causes of Serous Effusions[6]

Transudate		Exudate	
Pleural	**Peritoneal**	**Pleural**	**Peritoneal**
Congestive heart failure Cirrhosis of liver Hypoproteinemia Pulmonary embolism	Cirrhosis of liver Congestive heart failure Hypoproteinemia Hepatic vein occlusion Constrictive pericarditis	1..Infections 1.1 Parapneumonic effusion in bacterial pneumonia 1.2 Tuberculosis 2. Pulmonary infarction 3. Collagen disorders 3.1 Rheumatoid arthritis Systemic lupus erythematotus 3.2 Acute pancreatitis 4. Trauma to chest wall 5. Malignancy 6. Secondary deposits from bronchogenic carcinoma, carcinoma of breast 6.1 Lymphoma 6.2 Mesothelioma	Bacterial peritonitis (primary or secondary) Tuberculosis Malignancy (lymphoma, hepatoma, metastatic carcinoma) Abdominal injury Biliary peritonitis (rupture of gall bladder) Pancreatitis Chylous ascites (obstruction of or injury to thoracic duct)

Serous effusions present a spectrum of neoplastic and non-neoplastic conditions, either local or systemic.[7]. Thus, understanding the relative frequency and underlying mechanisms of serous effusions is essential for accurate interpretation and clinical correlation.

Diagnostic cytopathology is a rapid, inexpensive and simple diagnostic tool. Cytological examination is imperative to identiy non-inflammatory, inflammatory (acute or chronic) and Neoplastic aetiopathogenesis of effusion. The presence of malignant cells in the effusion is almost always indicative of metastatic tumours, as primary malignancies arising from the mesothelial cell lining are rare. In case of primary malignancy the tumour cells are usually found to be numerous and in clusters. A positive effusion for malignant cells is an important prognostic indicator in oncologic patients.[8] Sensitivity of cytological diagnosis of effusions for malignancy is 40-60%.[9]

Aspiration of serous cavities is a simple and relatively non-invasive technique to achieve diagnosis.[10] Thoracentesis is a commonly performed diagnostic and therapeutic procedure for removing fluid from the pleural space; by removing fluid, it helps alleviate symptoms like dyspnoea and provides crucial diagnostic information regarding the underlying cause of pleural fluid accumulation.[11] Adequate volume, timely fixation, and appropriate preparation techniques significantly influence diagnostic yield. Errors at the pre-analytical and analytical stages, such as delayed processing or improper fixation, may lead to cellular degeneration and compromise diagnostic yield.[12]

The conventional smear (CS) technique has long been the standard and most widely used method for the cytological evaluation of serous effusions in most laboratories worldwide.[13] Cytocentrifugation is preferred as it is less tedious and quicker than the membrane filtration, but at times it may cause cellular distortion. The cell block technique is a pivotal procedure of examining the body fluids. The procedure in toto along with concomitant use of conventional smears has shown an added advantage in making an accurate diagnosis. It is a technique of cell concentration without compromising the cellular content and preserving the tissue architecture. Preparation of cell block from the effusion sediment is desirable and is being frequently and increasingly requested by the clinician.[14, 15] Further, the effectiveness of the cell block lies in the availability of the diagnostic material for the further histological examination, histochemistry and IHC studies for a better classification of the tumour and for the identification of infectious causes by using microbiologic stains.[16] Clinicians should be aware of the high variability in diagnostic sensitivity by primary tumour type as well as the potential reasons for false-negative cytology results.[17]

In view of the wide spectrum of etiologies underlying serous effusions and the inherent diagnostic challenges associated with their evaluation, the present study was undertaken to assess the diagnostic yield and clinical utility of effusion cytology.

AIMS AND OBJECTIVES

The present study was undertaken to evaluate and compare the diagnostic efficacy of conventional cytological smears and cell block tissue sections in detecting malignancies in serous effusions. The objectives include comparing morphological findings in various serous effusions, assessing the individual diagnostic efficacy of conventional fluid cytosmear and cell block techniques and comparing the findings with other similar studies.

MATERIAL AND METHODS

This hospital-based, prospective cross-sectional study on 103 samples was conducted at the Department of Pathology, Jawaharlal Nehru Medical College and Associated Group of Hospitals, Ajmer (Rajasthan), from June 2024 to May 2025. The study was approved by the institutional ethical committee. All the fresh serous effusions samples (ascitic and pleural effusions) sent by various departments of the hospital were included and scanty fluid samples and deteriorated samples were excluded. The clinical information including age, sex, history, provisional diagnosis were noted. After routine physical examination of the effusion sample (colour, appearance) it was divided into two test tubes (5 ml each) for conventional cytology and cell block preparation. Contents from first test tube was transferred to a centrifugation tube and centrifuged at 1500 RPM for 5 minutes. Two thin smears was prepared from the sediment. One slide was wet fixed in 95% ethanol and stained with Haematoxylin and Eosin stain[18] and the second one was air dried and stained with May-Grunwald Giemsa (MGG)[10] stain.

Standard Operative Procedure For Cell Block [Plasma – Thromboplastin Method][9] : The cell block preparation involves enmeshing cellular material in a clot. A 5 ml serous fluid sample is centrifuged at 2000 rpm for 10 minutes, and the supernatant is discarded. The sediment is mixed with plasma and thrombin, allowed to form a soft ball, and then placed in filter paper and fixed for processing.

Tissue Processing For Histopathological Study: Prepared cell block was subjected to routine tissue processing. Then 3–5-micron sections were cut from paraffin embedded blocks. These sections were routinely stained with Harris Haematoxylin & Eosin stain[19] and was examined for presence of malignancy, histological type, and grade. Special stains (Periodic acid -Schiff stain / Mucicarmine) was used wherever found necessary. Quality of smears and cell blocks was assessed according to Mair's criteria.[20]

Scoring system according to Mair's criteria[20]

Criterion	Quantitative Description	Point Score
Volume of obscuring background blood or clot	a. Large amount: Diagnosis greatly compromised b. Moderate amount: Diagnosis possible c. Minimal amount: Diagnosis easy	0 1 2
Amount of diagnostic cellular material present	a. Minimal or absent: Diagnosis not possible b. Moderate: Diagnosis possible c. Abundant: Diagnosis easy	0 1 2
Degree of cellular degeneration and trauma	a. Marked: Diagnosis not possible b. Moderate: Diagnosis possible c. Minimal: Diagnosis easy	0 1 2
Retention of appropriate architecture and cellular arrangement	a. Minimal to absent: Non-diagnostic b. Moderate: Diagnosis possible c. Excellent: Diagnosis easy	0 1 2

0 to 2 points scores was given to individual smear/ cell blocks based on each of the above criteria, and the final score was calculated by adding the scores of four criteria.

Qualitative grouping of smears and cell blocks[9]

Qualitative Grouping	Total Score
a. Diagnostically unsuitable	0 - 2
b. Diagnostically adequate	3 - 5
c. Diagnostically superior	6 - 9

The cytological smears and block sections were examined separately for quality, cellularity, architectural patterns and morphology (cytoplasmic and nuclear details) to render a diagnosis for each case, and the findings was compared. Cytomorphological features were studied to identify the malignancy. Yield for malignancy was calculated by both methods. Diagnostic yield of both conventional smear and cell block method for diagnosing malignancy was calculated.

Statistical Analysis: Statistical analysis was done using computer software (SPSS Trial version 23 and primer). Qualitative data was expressed in proportions and percentages and the quantitative data was expressed as mean and standard deviations. The appropriate test of significance was applied. 5% probability was considered as statistically significant i.e. $p<0.05$.

RESULTS

Table 1 : Age Wise Distribution of Cases

Age Range (years)	Number of patients	Percentage (%)	P value (Chi Square Test)
< 10	**0**	0.00	**<0.0001 (S)**

11-20	2	1.94	
21-30	10	9.71	
31-40	15	14.56	
41-50	24	23.30	
51-60	18	17.48	
61-70	22	21.36	
> 70	12	11.65	
Total	**103**	**100**	

Table 2 : Sex Wise Distribution of Cases

Sex	No. of patients	Percentage (%)	P value
Male	67	65.05	0.0023 (S)
Female	36	34.95	
Total	**103**	**100**	

Table 3 : Comparative Quality Evaluation of Conventional Smear and Cell Block Cytology (According to Mair's Criteria)

PARAMETERS	CONVENTIONAL SMEAR		CELL BLOCK		P Value
	No. of Patients	Percentage (%)	No. of Patients	Percentage (%)	
BACKGROUND BLOOD					
SCORE 0	6	5.77	1	0.96	P<0.0001 (S)
SCORE 1	63	60.58	43	41.35	
SCORE 2	34	32.69	59	56.73	
AMOUNT OF DIAGNOSTIC MATERIAL (CELLULARITY)					
SCORE 0	10	9.62	2	1.92	P<0.0001 (S)
SCORE 1	69	66.35	45	43.27	
SCORE 2	24	23.08	56	53.85	
DEGREE OF CELLULAR DEGENERATION					
SCORE 0	13	12.50	1	0.96	P<0.0001 (S)
SCORE 1	59	56.73	42	40.38	
SCORE 2	31	29.81	60	57.69	
DISTRIBUTION OF CELLS					
SCORE 0	76	73.08	42	40.38	P<0.0001 (S)
SCORE 1	25	24.04	36	34.62	
SCORE 2	2	1.92	25	24.04	

Table 4 : Descriptive Statistic for each of the Four Parameters of Conventional Smear and Cell Block Cytology

Parameters	Conventional Smear (Mean $\pm$ SD)	Cell Block (Mean $\pm$ SD)	P Value
Background Blood	1.27 ± 0.56	1.56 ± 0.51	0.0001
Amount of Diagnostic Material (Cellularity)	1.13 ± 0.56	1.52 ± 0.53	P<0.0001
Degree of Cellular Degeneration	1.17 ± 0.63	1.57 ± 0.51	P<0.0001
Distribution of Cells	0.28 ± 0.49	0.83 ± 079	P<0.0001

Table 5 : Diagnostic Scores of Conventional Smear and Cell Block Sections

Diagnostic Score	Conventional Smear		Cell Block		P - value (Chi Square test)
	Number	(%)	Number	(%)	
Diagnostically Superior (6-9)	14	13.59	56	54.37	P<0.0001 (S)

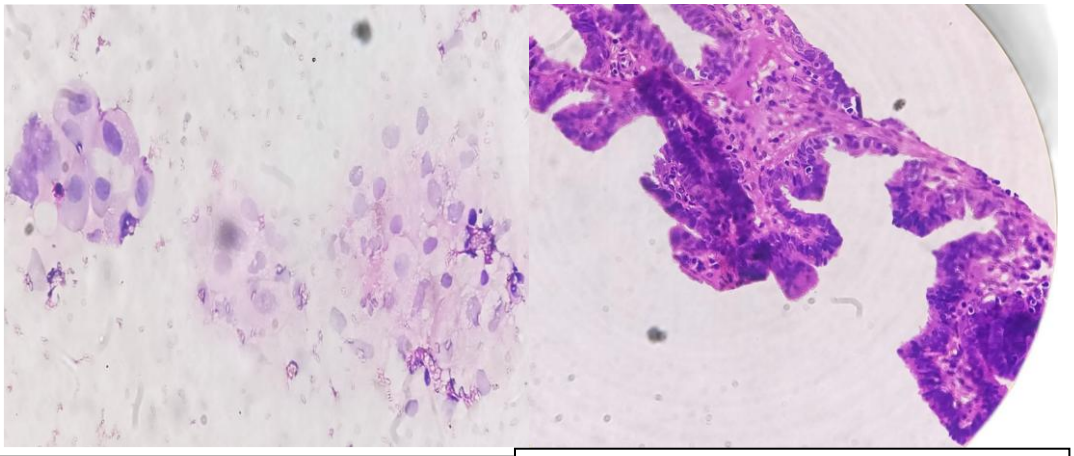
Diagnostically Adequate (3-5)	75	72.82	46	44.66	
Diagnostically Unsuitable (0-2)	14	13.59	1	0.97	
Total	**103**	**100**	**103**	**100**	

Table 6 : Comparison of Cytological Diagnosis on Conventional Smear and Cell Block Study

DIAGNOSIS	**CONVENTIONAL CYTOSMEAR**		**CELL BLOCK**		**P value**
	No. of patients	**(%)**	**No. of patients**	**(%)**	
Benign					
Chronic inflammatory	47	45.63	45	43.69	0.8886 (NS)
Inflammatory (Mix)	23	22.33	33	32.04	0.1584 (NS)
Non inflammatory	14	13.59	10	9.71	0.5155 (NS)
Acute Inflammatory	7	6.8	10	9.71	0.6138 (NS)
Suspicious for malignancy	10	9.71	0	0	0.0016 (HS)
Malignancy	2	1.94	5	4.85	0.445 (NS)
Total	**103**	**100**	**103**	**100**	

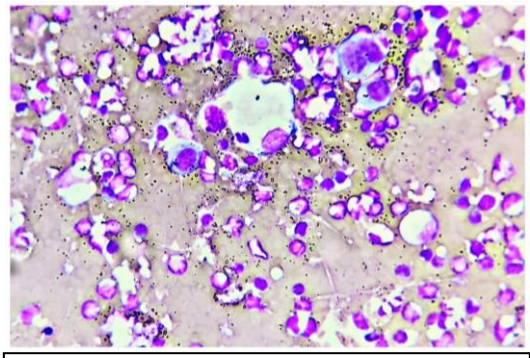
Table 7 : Comparison of Cytological Diagnosis in Pleural and Ascitic Fluid

Diagnosis by cell block tissue sections	**Ascitic fluid**	**Pleural fluid**	**Grand Total**
Inflammatory (Mix)	14	19	33
Acute Inflammatory	2	8	10
Chronic inflammatory	8	37	45
Non inflammatory	2	8	10
Malignancy	4	1	5
Suspicious for malignancy	0	0	0
Total	**30**	**73**	**103**

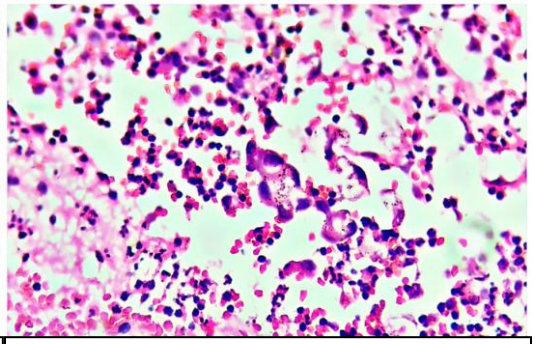


Conventional smear-Metastatic deposits of Adenocarcinoma (H & E 40X)

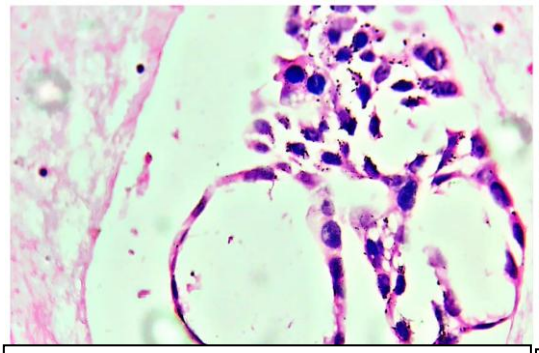
Cell Block – Metastatic deposits of Adenocarcinoma : Pappillary pattern (H & E 40X)



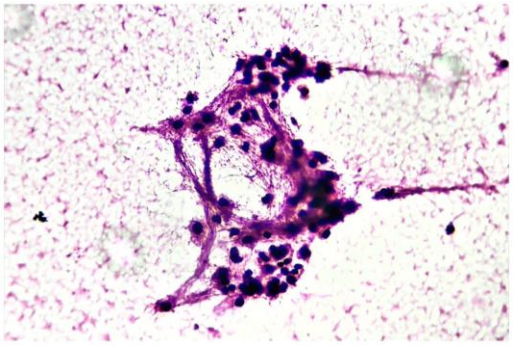
Cell block : Diagnosed as Mesothelial Hyperplasia [Mair's Score – 7 ; Diagnostically superior] (H & E 400 X)



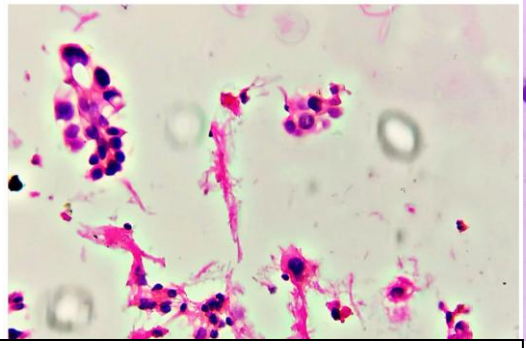
Conventional Smear : Diagnosed as Suspicious for Malignancy [Mair's Score – 4 ; Diagnostically adequate] (Giemsa 400 x)



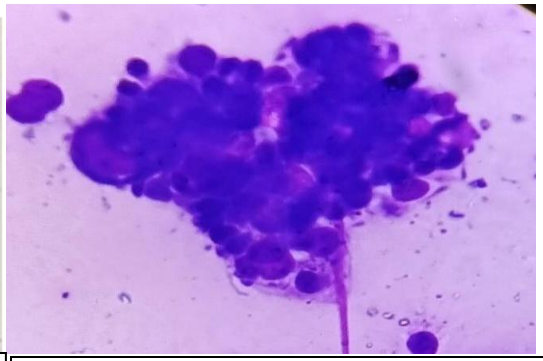
Cell block : Diagnosed as Metastatic Deposits of Adenocarcinoma [Mair's Score – 6 ; Diagnostically superior] (H & E 400 x)



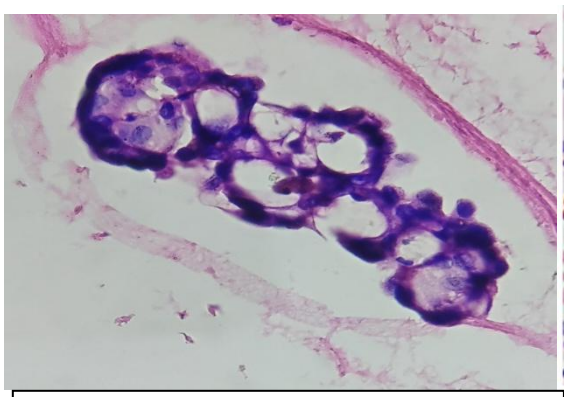
Conventional Smear : Diagnosed as Suspicious for Malignancy [Mair's Score – 4 ; Diagnostically adequate] (H & E 400 x)



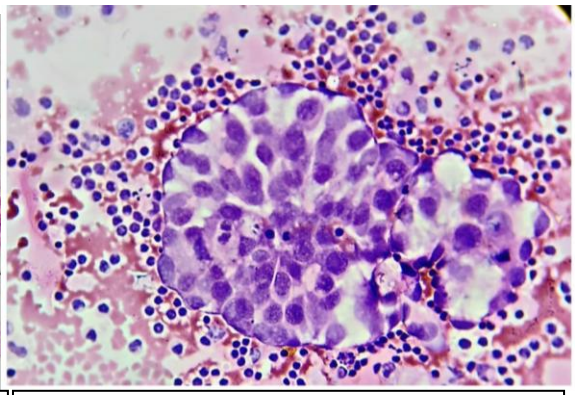
Conventional Smear : Diagnosed as Metastatic Deposits of Adenocarcinoma [Mair's Score – 6 ; Diagnostically superior] (Giemsa 400 x)



Conventional Smear : Diagnosed as Metastatic Deposits of Adenocarcinoma [Mair's Score – 7 ; Diagnostically superior] (H & E 400 x)



Conventional Smear : Diagnosed as Metastatic Deposits of Adenocarcinoma [Mair's Score – 6 ; Diagnostically superior] (H & E 400 x)



Conventional Smear : Diagnosed as Metastatic Deposits of Adenocarcinoma [Mair's Score – 7 ; Diagnostically superior] (H & E 400 x)

DISCUSSION

The present study aimed to prospectively evaluate and compare the diagnostic efficacy of Conventional Smear (CS) versus Cell Block (CB) techniques on 103 serous effusion samples and to contextualize these findings within the existing body of literature.

In this study, serous effusions were most frequently observed in patients in the 41-50 years (23.30%) and 61-70 years (21.36%) age groups. The findings of the present study align closely with Bansode S et al. (2015)[21], Padmavathi A et al. (2016)[22] and Dehariya C et al. (2020)[23]. This suggests that while the overall age trend remains stable over time, the most significant concentration of cases in this study occurred in the fifth decade of life. This consistency across studies underscores that the diagnostic challenge of evaluating serous effusions is most pertinent to patients over 40 years.

The gender distribution in the Present Study indicates a notable male predominance, with a male-to-female ratio of approximately 1.86:1. These findings align most closely with the study by Bansode S et al. (2015)[21], which reported a higher male-to-female ratio of 2:1., Dehariya C et al. (2020)[23] and Chandan RH et al. (2021)[58/24] observed 1.06:1 and 1.08:1 respectively.

Comparison of Morphological Quality of Conventional Smear and Cell Block

Study	Finding on CB Morphological Quality
Bansode S et al. (2015)[21]	Provides high cellularity and a better architectural pattern.
Matreja SS et al. (2017)[25]	Provides higher cellularity, better architectural patterns, and an additional yield for malignancy.
Dehariya C et al. (2020)[23]	CB was rated "diagnostically superior" in 34.02% of cases, whereas no CS was rated as such.
Present Study (2025)	**Statistically superior cellularity, less background blood, and less cellular degeneration compared to CS.**

This study found that the CB method was statistically superior to CS in three of the four parameters ($P<0.0001$ for all):
The present study confirms that the cell block (CB) technique significantly enhances diagnostic yield, achieving a 2.91% absolute increase in malignancy detection and a 100% resolution of "suspicious" cases. This improvement aligns with findings by Dey S et al. (2017) [22% additional yield of malignancy by CB over CS (48% vs.26%)][27], who similarly resolved suspicious smears using CB. While the additional yield in this study is more conservative than the 11.94% to 19.23% reported by Dehariya C et al. (2020)[23], Chandan RH et al. (2021)[24] (Increased malignancy detection in both pleural (7 to 12 cases) and ascitic fluids (8 to 15 cases) and Datta P et al. (2020)[28] (19.23% additional yield of malignancy by CB over CS (37.5% vs. 18.27%), it supports the consistent trend of increased sensitivity also noted by Grandhi B et al. (2014)[26] (Increased malignancy detection in both pleural (7 to 12 cases) and ascitic fluids (8 to 15 cases). Overall, the results reinforce the role of CB in providing definitive diagnoses and reducing diagnostic ambiguity.

CONCLUSION

Cell block technique demonstrated superior morphological preservation and improved diagnostic yield compared with conventional smear cytology. By employing tissue-processing principles, the cell block acts as a "mini-biopsy." It inherently concentrates exfoliated cells, eliminates obscuring hemorrhagic and proteinaceous backgrounds, and crucially

preserves three-dimensional cellular architecture and spatial arrangements. These morphological enhancements directly translate to superior diagnostic yield.

The most significant clinical advantage of the cell block method is its ability to bridge the diagnostic gap between cytology and histology. By converting ambiguous, "suspicious" cytological smears into definitive benign or malignant diagnoses, the cell block prevents unnecessary diagnostic delays, reduces the need for subsequent invasive surgical procedures (such as pleural or peritoneal biopsies), and facilitates the immediate initiation of targeted patient management. Furthermore, cell block may facilitate ancillary techniques such as immuno-histochemistry and molecular studies.

ACKNOWLEDGEMENT
The authors wish to acknowledge the Department of Pathology, JLN Medical College Ajmer for its support and opportunity. The authors also wish to acknowledge Dr. Shailendra Vashistha (Assistant Professor, Transplant Immunology – HLA Lab, Department of IHTM, GMC, Kota) and the VAssist Research team (www.thevassist.com) for their contribution in journal selection and manuscript submission process.

Conflict of interest: None
Source of funding: Nil

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