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Original Research Article

Diagnostic Utility of Cell Block Method versus Conventional Smear Study in Pleural and Peritoneal Fluid

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Abstract

Background: Cytological examination of pleural and peritoneal fluids is an important diagnostic tool for identifying benign and malignant conditions. Conventional smear examination has certain limitations in cellular architecture assessment, whereas the cell block method may provide additional morphological information.

Aim: To compare the diagnostic utility of the cell block method and conventional smear examination in pleural and peritoneal fluid cytology.

Materials and Methods: This cross-sectional descriptive study was conducted at Pacific Institute of Medical Sciences, Umarda, Udaipur, Rajasthan, over 18 months, from May 2024 to October 2025. A total of 200 pleural and ascitic fluid samples were examined using conventional smear and cell block techniques. Cytological findings, cellularity, architectural preservation, and diagnostic performance were compared.

Results: Among the 200 samples, 116 (58%) were pleural and 84 (42%) were ascitic fluids. Conventional smear examination identified 15 (7.5%) malignant cases, whereas cell block examination identified 20 (10%). Benign diagnoses accounted for 178 (89%) cases on conventional smears and 175 (87.5%) cases on cell block examination. Excellent architectural preservation was reported in 90% of cell block preparations. The reported sensitivity for malignancy was 83.33% for conventional smears and 100% for the cell block method.

Conclusion: The cell block method demonstrated additional diagnostic yield for malignancy and improved architectural preservation compared with conventional smear examination. Its use as an adjunct to conventional cytology may enhance the diagnostic evaluation of pleural and peritoneal effusions, particularly in cases suspicious for malignancy.

Keywords: Cell Block; Conventional Smear; Pleural Effusion; Ascitic Fluid; Effusion Cytology; Malignancy.

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Introduction

Serous effusions are abnormal accumulations of fluid within body cavities, including the pleural and peritoneal cavities, and may result from infections, inflammatory disorders, systemic diseases, and malignancies. Cytological examination of these fluids is a minimally invasive diagnostic procedure that plays an important role in identifying the underlying pathology and guiding clinical management [1,2]. Conventional smear (CS) examination is widely used in routine effusion cytology because of its simplicity, low cost, and rapid turnaround time. However, its diagnostic utility may be limited by low cellularity, overlapping cells, obscuring inflammatory material, and difficulties in differentiating reactive mesothelial cells from malignant cells. The absence of preserved tissue architecture may further complicate the interpretation of diagnostically challenging specimens [2,3]. The cell block (CB) method has emerged as a useful adjunct to conventional smear examination. It involves concentrating cellular material from fluid specimens, followed by fixation, paraffin embedding, sectioning, and microscopic

examination. This technique facilitates better assessment of cellular architecture and clustering and allows additional investigations, including special staining and immunohistochemistry, when indicated [3,4]. Previous studies have demonstrated that cell block examination may improve the detection of malignant cells and provide additional diagnostic information when conventional smears are inconclusive. Shivakumarswamy et al. reported the diagnostic utility of cell block preparation in pleural fluid cytology, while Thapar et al. demonstrated the value of combining smear and cell block techniques in effusion analysis [4,5]. Nevertheless, the diagnostic yield of cell block examination may vary according to specimen cellularity, fluid volume, and processing technique. Its additional processing requirements and resource implications must also be considered.

Therefore, the present study aims to compare the diagnostic utility of cell block examination and conventional smear study in pleural and peritoneal fluids, focusing on cellularity, morphological preservation, detection of pathological conditions, and comparative diagnostic performance. The study also evaluates the additional diagnostic contribution of cell block examination when used alongside conventional smears, with the objective of improving the reliability of effusion cytology.

Material & Methodology

A cross-sectional descriptive study was conducted in the Department of Pathology at Pacific Institute of Medical Sciences, Umarda, Udaipur, Rajasthan, following approval from the Institutional Ethics Committee. The study was carried out over 18 months, from May 2024 to October 2025, and included consecutive pleural and peritoneal (ascitic) fluid samples received for diagnostic evaluation. The sample size was calculated using an estimated prevalence of 15%, a 95% confidence level, and 5% absolute precision, yielding a minimum sample size of approximately 196, which was rounded to 200. Samples from patients of all age groups with adequate fluid volume for both techniques were included. Samples with insufficient volume, significant contamination affecting interpretation, or inadequate clinical information were excluded.

Each sample was divided into two aliquots for conventional smear and cell block preparation. For conventional smear examination, smears were prepared on glass slides, appropriately fixed, and stained using Papanicolaou and Giemsa stains. For cell block preparation, the fluid samples were centrifuged at 2500 rpm for 15 minutes, and the supernatant was discarded. Two drops each of thromboplastin and pooled plasma were added to the sediment, followed by centrifugation at 2500 rpm for 3 minutes. The resulting cell button was wrapped in filter paper, fixed in 10% formalin for 8 hours, processed routinely for paraffin embedding, sectioned, and stained with hematoxylin and eosin. Both preparations were examined microscopically for cellularity, cellular morphology, inflammatory changes, malignant cells, and overall diagnostic findings. Cytological diagnoses were categorized as nondiagnostic, negative for malignancy, atypia of undetermined significance, suspicious for malignancy, or malignant.

Data were recorded in a predefined proforma and analyzed using SPSS version 26.0. Qualitative variables were expressed as frequencies and percentages, while quantitative variables were summarized as mean ± standard deviation or median and interquartile range, as appropriate. Diagnostic sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were calculated wherever an appropriate reference standard was available. A p-value of less than 0.05 was considered statistically significant.

Result

A total of 200 pleural and peritoneal fluid samples were evaluated using conventional smear and cell block techniques. Of these, 116 (58%) were pleural fluid samples and 84 (42%) were ascitic fluid samples. The study population comprised 142 (71%) males and 58 (29%) females, with a male-to-female ratio of approximately 2.45:1. The largest age group was 41–60 years, comprising 62 (31%) patients, followed by those aged above 60 years (61; 30.5%), 21–40 years (60; 30%), and 0–20 years (17; 8.5%). On conventional smear examination, 178 (89%) cases were classified as benign, 15 (7.5%) as malignant, five (2.5%) as suspicious for malignancy, and two (1%) as inadequate. Cell block examination classified 175 (87.5%) cases as benign, 20 (10%) as malignant, three (1.5%) as suspicious for malignancy, and two (1%) as inadequate. Thus, cell block examination identified five additional malignant cases compared with conventional smear examination.

Regarding architectural preservation, the supplied data indicated an excellent architectural pattern in 180 (90%) cell block preparations, compared with 164 cases reported for conventional smears. Moderate architecture was observed in 20 (10%) cell block preparations and 36 conventional smears. The reported difference was statistically significant ($p = 0.0076$); however, the conventional smear counts and percentages require verification before publication. The reported diagnostic performance showed a sensitivity of 83.33% for conventional smears and 100% for cell block examination in detecting malignancy. Specificity and positive predictive value were reported as 100% for both techniques. The negative predictive value was 98.38% for conventional smears and 100% for cell

block examination. Overall diagnostic accuracy was reported as 98.5% and 100%, respectively. These performance estimates should be verified against the original case-wise data and reference standard before submission.

Table 1: Demographic and Clinical Characteristics of the Study Population

Characteristic	Number (%)
Fluid type	
Pleural fluid	116 (58.0)
Ascitic fluid	84 (42.0)
Gender	
Male	142 (71.0)
Female	58 (29.0)
Age group (years)	
0–20	17 (8.5)
21–40	60 (30.0)
41–60	62 (31.0)
>60	61 (30.5)
Total	200 (100)

Table 2: Comparison of Final Cytological Diagnoses by Conventional Smear and Cell Block Methods

Final diagnosis	Conventional smear, n (%)	Cell block, n (%)
Inadequate	2 (1.0)	2 (1.0)
Benign	178 (89.0)	175 (87.5)
Suspicious for malignancy	5 (2.5)	3 (1.5)
Malignant	15 (7.5)	20 (10.0)
Total	200 (100)	200 (100)

Table 3: Comparison of Architectural Preservation and Diagnostic Performance

Parameter	Conventional smear	Cell block
Excellent architectural pattern, n (%)	164*	180 (90.0)
Moderate architectural pattern, n (%)	36*	20 (10.0)
Sensitivity for malignancy (%)	83.33	100.00
Specificity for malignancy (%)	100.00	100.00
Positive predictive value (%)	100.00	100.00
Negative predictive value (%)	98.38	100.00
Diagnostic accuracy (%)	98.50	100.00

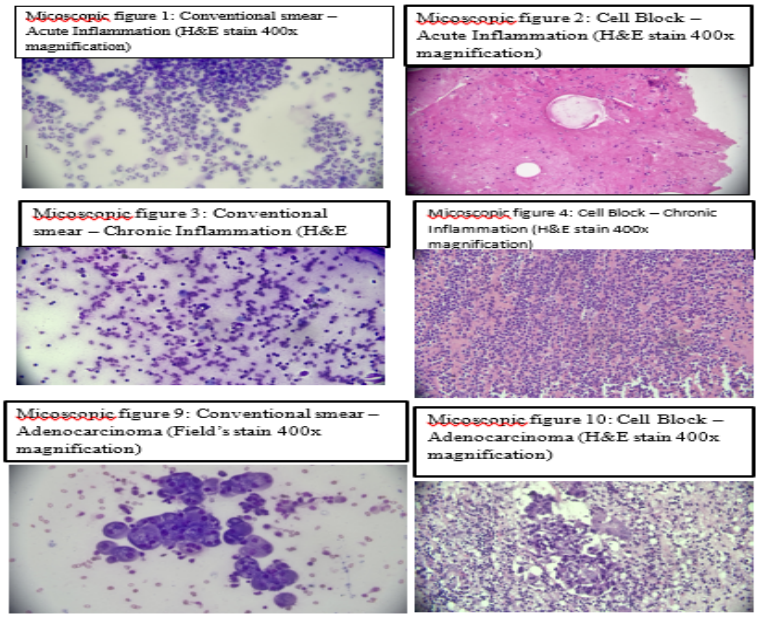


Figure 1:

Discussion

Effusion cytology is an important diagnostic tool for evaluating pleural and peritoneal fluid collections associated with inflammatory, infectious, and malignant conditions. The identification of malignant cells in effusions contributes to diagnosis, staging, prognosis, and treatment planning. Conventional smear (CS) examination and cell block (CB) preparation are established techniques in the cytological evaluation of serous effusions, with cell block preparation offering additional architectural details and opportunities for ancillary investigations [6,7].

In the present study, pleural fluid constituted 58% of the samples, while ascitic fluid accounted for 42%. Males represented 71% of the study population, and the highest proportion of patients belonged to the 41–60 years age group (31%). Similar male predominance was reported by Biswas et al., who observed that males constituted 66.6% of their study population [8]. In contrast, Matreja et al. reported an almost equal gender distribution, with males accounting for 50.3% and females for 49.7%, demonstrating demographic variations between study populations [9].

Conventional smear examination classified 89% of the samples as benign, 7.5% as malignant, and 2.5% as suspicious for malignancy. In comparison, the cell block method identified 87.5% as benign, 10% as malignant, and 1.5% as suspicious. The five additional malignant diagnoses reported with the cell block method suggest its potential value in cases where conventional smears do not demonstrate definitive malignant features. Similar findings were reported by Gayathri et al., who identified 15 malignant cases using cell block examination compared with 13 using conventional cytology.[10] Shivakumarswamy et al. also reported increased detection of malignant cells using the cell block method in pleural effusions [4]. These findings support the use of cell block preparation as an adjunct to conventional cytology.

Among inflammatory lesions, chronic inflammation was more frequently observed than acute inflammation with both techniques. Conventional cytology demonstrated chronic inflammatory changes in 52% of cases and acute inflammation in 34.5%, while the corresponding proportions with cell block examination were 50.5% and 34.5%, respectively. These findings indicate broadly comparable patterns of inflammatory diagnoses with the two methods. However, the reported benign case totals and inflammatory categories should be verified against the original dataset before publication. Architectural preservation was an important area of comparison in the present study. Excellent architectural patterns were reported in 90% of cell block preparations compared with approximately 80% of conventional smears, while moderate architectural preservation was less frequent with cell block examination. The reported difference was statistically significant ($p = 0.0076$). Better preservation of cell clusters and tissue-like arrangements may facilitate morphological assessment and help distinguish reactive mesothelial cells from malignant cells. Similar advantages were described by Thapar et al., who reported improved architectural detail and a higher malignancy detection rate with cell block examination than with conventional smears [5]. Pal et al. also reported improved cellularity and better demonstration of cell clusters and papillary formations using the cell block method in ascitic fluid samples [11]. Architectural preservation is an important advantage because it may assist in the interpretation of diagnostically challenging specimens [12].

The diagnostic performance results supplied for the present study showed a sensitivity of 83.33% for conventional smear examination and 100% for cell block examination in detecting malignancy. Both methods were reported to have 100% specificity and positive predictive value for malignant effusions. The higher reported sensitivity of cell block examination suggests that additional malignant cases may be detected through improved cellular concentration and architectural assessment. Matreja et al. similarly reported higher sensitivity with cell block examination than with conventional cytology (92.3% versus 69.2%) and higher overall diagnostic accuracy (98.6% versus 92.8%) [9]. Thapar et al. also reported improved sensitivity and accuracy with cell block examination [5]. Nevertheless, these comparisons should be interpreted cautiously because differences in study populations, specimen processing, and reference standards may influence diagnostic performance.

The findings support the complementary role of cell block examination in routine effusion cytology. Conventional smears remain useful because they are simple, economical, and relatively rapid, whereas cell block preparations provide additional architectural information and material for ancillary investigations, including immunohistochemistry when indicated [3, 13]. Assawasaksakul et al. reported that combining conventional smears and cell block preparations improved sensitivity in malignant pleural effusions, further supporting the use of both techniques together [14]. The Indian Academy of Cytologists guidelines also provide recommendations for the collection, preparation, interpretation, and reporting of serous effusion samples [15]. The present study is limited by its single-centre design and the absence of clearly documented independent confirmation of all cytological diagnoses in the supplied results.

Furthermore, the reported diagnostic performance estimates, cross-tabulation of diagnoses, and architectural-pattern distributions require verification using the original case-wise data before definitive conclusions can be drawn. Overall, cell block examination demonstrated a higher observed detection of malignant effusions and better reported architectural preservation than conventional smear examination. Its use alongside conventional cytology may improve the diagnostic evaluation of pleural and peritoneal fluids, particularly in cases suspicious for malignancy or with inconclusive smear findings

Conclusion

The cell block method demonstrated a higher diagnostic yield for malignancy and better architectural preservation than conventional smear examination in pleural and peritoneal fluids. Conventional smears remain valuable due to their simplicity and cost-effectiveness. Combining both techniques may improve the diagnostic evaluation of serous effusions. Therefore, cell block examination is recommended as a complementary method, particularly in cases suspicious for malignancy or with inconclusive conventional smear findings.

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