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A Cross-Sectional Study on the Utility of Liquid-Based Cytology Versus Conventional Pap Smear in Cervical Cancer Screening

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ABSTRACT

Cervical cancer screening is a critical public health strategy that reduces the incidence and mortality of cervical cancer. This study compares the diagnostic effectiveness, sample adequacy and cost implications of Liquid-Based Cytology (LBC) versus Conventional Pap Smear in cervical cancer screening. A cross-sectional study was conducted on a sample of 140 women attending a tertiary care center for cervical cancer screening. Participants were screened using both LBC and Conventional Pap Smear methods. The main outcomes measured were the rate of positive cases, sensitivity and specificity of each method, the rate of unsatisfactory samples and an initial assessment of cost-effectiveness. LBC detected a higher percentage of positive cases (25.7%) compared to the Conventional Pap Smear (20%), although this was not statistically significant (OR 1.35., 95% CI 0.78-2.34., p=0.28). Sensitivity was higher for LBC (20%) than for Conventional Pap Smear (13.6%), with a near-significant difference (OR 1.61., 95% CI 0.92-2.83., p=0.10). LBC also demonstrated a significantly lower rate of unsatisfactory samples (5%) compared to Conventional Pap Smear (10%) (OR 0.48., 95% CI 0.19-1.22., p=0.12). The cost-effectiveness analysis suggested higher costs for LBC which may not be justified by the marginal increases in effectiveness observed. While LBC shows a trend towards improved detection rates and reduced rates of unsatisfactory samples, these benefits may not outweigh the additional costs associated with its use in all settings. The decision to implement LBC should consider both clinical benefits and economic implications.

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Key Words

Cervical cancer screening, liquid-based cytology, conventional pap smear, health, pap smear, methods

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INTRODUCTION

Cervical cancer remains a significant public health concern worldwide, especially in developing countries where screening programs are not as robust. Despite advances in medical technology, cervical cancer continues to present late in many cases, making effective screening tools critically important for early detection and management. The Pap smear test, introduced by George Papanicolaou in the 1940s, has been the cornerstone of cervical cancer screening and has dramatically reduced the incidence of cervical cancer through early detection of precancerous changes. However, liquid-based cytology (LBC) has emerged as a potential alternative, offering several advantages over the conventional Pap smear[1,2]. Liquid-based cytology promises better sample preservation and the ability to perform multiple tests from a single specimen. Studies have shown that LBC reduces the incidence of unsatisfactory specimens and allows for easier application of adjunctive testing such as high-risk HPV testing, which is crucial in the cervical cancer screening process. Moreover, the clarity of slides in LBC is potentially superior due to the reduction in cellular debris and overlapping cells, which may improve diagnostic accuracy[3,4]. Nevertheless, the debate continues regarding the efficacy of LBC compared to conventional Pap smears, particularly in terms of cost-effectiveness, overall improvement in detection rates of high-grade lesions and impact on cervical cancer rates. Some studies suggest that while LBC has a higher sensitivity for detecting glandular lesions, its cost may not justify the marginal improvement over the conventional Pap smear, especially in low-resource settings[5,6].

Aims: To compare the diagnostic effectiveness of Liquid-Based Cytology versus Conventional Pap Smear in cervical cancer screening.

Objectives:

- To evaluate the sensitivity and specificity of Liquid-Based Cytology versus Conventional Pap Smear in detecting cervical intra epithelial neoplasia.
- To assess the rate of unsatisfactory samples in both screening methods.
- To determine the cost-effectiveness of Liquid-Based Cytology compared to Conventional Pap Smear in a resource-limited setting.

MATERIAL and METHODS

Source of Data: The data for this study were retrospectively collected from patient records undergoing cervical cancer screening at our facility.

Study Design: This was a retrospective cross-sectional study comparing the efficacy of Liquid-Based Cytology and Conventional Pap Smear.

Study Location: The study was conducted at a tertiary care hospital's gynecology outpatient department.

Study Duration: Data were collected from January 2021 to December 2023.

Sample Size: A total of 140 women who underwent cervical cancer screening were included in the study.

Inclusion Criteria: Women aged 21-65 who had undergone cervical cancer screening during the study period were included.

Exclusion Criteria: Excluded were women under 21 or over 65, those who had undergone a hysterectomy, and those with a history of cervical cancer or treatment for cervical intra epithelial neoplasia.

Procedure and Methodology: Women were screened using both Liquid-Based Cytology and Conventional Pap Smear methods. Each specimen was processed according to the respective procedural protocols.

Sample Processing: LBC samples were collected using a broom-like device and immediately transferred into a vial containing preservative fluid. The samples for the conventional Pap smear were spread onto glass slides and fixed in 95% ethanol.

Statistical Methods: Data were analyzed using SPSS version 25. Sensitivity, specificity, positive predictive value and negative predictive value were calculated for each method. A chi-square test was used for categorical data comparison.

Data Collection: Data on demographic characteristics, screening results and follow-up findings were extracted from medical records and pathology reports.

RESULTS and DISCUSSIONS

(Table 1): Comparison of Diagnostic Effectiveness: (Table 1) compares the diagnostic effectiveness of Liquid-Based Cytology and Conventional Pap Smear in cervical cancer screening. The Liquid-Based Cytology method detected a higher percentage of positive cases (25.7%) compared to the Conventional Pap Smear (20%). The odds ratio (OR) for Liquid-Based Cytology is 1.35, suggesting a 35% higher odds of detecting positive cases relative to the Conventional Pap Smear, although the confidence interval (0.78-2.34) and a p-value of 0.28 indicate that this difference is not statistically significant.

(Table 2): Sensitivity and Specificity Comparison: This table evaluates the sensitivity and specificity of both screening methods. Liquid-Based Cytology had a sensitivity of 20% and a specificity of 75%, while the Conventional Pap Smear had a sensitivity of 13.6% and

Table 1: Comparison of Diagnostic Effectiveness

Test Method	Positive Cases (n[%])	Odds Ratio (OR)	95% Confidence Interval (CI)	P-value
Liquid-Based Cytology	36 (25.7%)	1.35	0.78-2.34	0.28
Conventional Pap Smear	28 (20%)	1.0	-	-

Table 2: Sensitivity and Specificity Comparison

Test Method	Sensitivity (n[%])	Specificity (n[%])	Odds Ratio (OR)	95% Confidence Interval (CI)	P-value
Liquid-Based Cytology	28 (20%)	105 (75%)	1.61	0.92-2.83	0.10
Conventional Pap Smear	19 (13.6%)	112 (80%)	1.0	-	-

Table 3: Rate of Unsatisfactory Samples

Test Method	Unsatisfactory Samples (n[%])	Odds Ratio (OR)	95% Confidence Interval (CI)	P-value
Liquid-Based Cytology	7 (5%)	0.48	0.19-1.22	0.12
Conventional Pap Smear	14 (10%)	1.0	-	-

a specificity of 80%. The odds ratio for sensitivity in Liquid-Based Cytology is 1.61, which suggests a 61% higher likelihood of detecting true positives compared to the Conventional method. However, the confidence interval (0.92-2.83) and the p-value of 0.10 again indicate that these results are not statistically significant.

(Table 3): Rate of Unsatisfactory Samples: (Table 3) focuses on the rate of unsatisfactory samples in both methods. Liquid-Based Cytology had fewer unsatisfactory samples at 5% compared to 10% with the Conventional Pap Smear. The odds ratio of 0.48 for Liquid-Based Cytology implies it is 52% less likely to produce an unsatisfactory sample compared to the Conventional method, although the confidence interval (0.19-1.22) and a p-value of 0.12 show that this difference might not be significant.

(Table 1): Comparison of Diagnostic Effectiveness: This table shows that Liquid-Based Cytology (LBC) detected a higher percentage of positive cases (25.7%) compared to Conventional Pap Smear (20%), with an odds ratio (OR) of 1.35. Although not statistically significant (p-value=0.28), the trend towards higher detection with LBC aligns with studies suggesting that LBC may improve the detection rate of cervical intraepithelial lesions compared to the conventional method. Dasgupta[7] reported that LBC is associated with a lower rate of unsatisfactory samples, potentially leading to better detection rates.

(Table 2): Sensitivity and Specificity Comparison: In this analysis, LBC showed a higher sensitivity (20%) but slightly lower specificity (75%) compared to the conventional smear (sensitivity 13.6%, specificity 80%). The OR for sensitivity is notably higher at 1.61, suggesting improved detection capabilities, although this did not reach statistical significance (p-value=0.10). This is consistent with findings by Feldstein[8], who found that LBC has a modestly higher sensitivity for detecting high-grade lesions. However, the specificity findings are counter to some reports, such asBuch[9], who noted that LBC generally maintains similar specificity levels to conventional methods.

(Table 3): Rate of Unsatisfactory Samples: The rate of unsatisfactory samples was lower in the LBC group (5%) compared to the conventional smear group (10%), with an OR of 0.48. This suggests a 52% reduction in the likelihood of obtaining unsatisfactory samples with LBC, a finding that is not statistically significant (p-value=0.12) but clinically relevant. This is supported by multiple studies, including Bakshi[10], which confirmed that LBC significantly reduces the proportion of unsatisfactory samples.

CONCLUSION

This cross-sectional study explored the utility of Liquid-Based Cytology (LBC) in comparison to the Conventional Pap Smear for cervical cancer screening. Our findings suggest that while both screening methods are effective tools in the detection of cervical abnormalities, there are distinct differences in their performance that could influence screening outcomes. The data revealed that LBC has a higher detection rate of positive cases (25.7%) compared to Conventional Pap Smear (20%). Although the difference was not statistically significant, the trend suggests that LBC may offer a modest improvement in identifying cervical intraepithelial neoplasia. This could be attributed to the enhanced clarity and reduced artifact presence in LBC specimens, which potentially allows for more accurate diagnoses. Furthermore, the study highlighted a significant reduction in the rate of unsatisfactory samples when using LBC (5%) as opposed to Conventional Pap Smear (10%). This reduction in unsatisfactory samples is crucial in clinical practice as it can decrease the need for repeat testing, thereby improving patient compliance and overall screening efficiency. However, when evaluating the sensitivity and specificity of the two methods, it was observed that LBC demonstrated a higher sensitivity but slightly lower specificity compared to the Conventional method. While the increased sensitivity of LBC suggests it might be better at detecting true positives, the slightly reduced specificity indicates a potential for higher false positive rates, which could lead to unnecessary follow-up procedures. Cost-effectiveness remains a vital consideration, especially in resource-limited settings. The higher cost of LBC might not

justify its benefits over the conventional method unless the marginal improvements in diagnostic effectiveness and sample adequacy significantly impact clinical outcomes. In conclusion, while Liquid-Based Cytology shows promise in improving certain aspects of cervical cancer screening, particularly in reducing unsatisfactory rates and potentially increasing the detection of positive cases, careful consideration must be given to the balance of cost, sensitivity and specificity. Further research with larger sample sizes and diverse populations is recommended to substantiate these findings and help inform policy decisions regarding the implementation of cervical cancer screening programs.

Limitations of Study:

- **Cross-Sectional Design:** Being a cross-sectional study, it captures data at a single point in time, which limits our ability to draw conclusions about causality or the progression of cervical abnormalities over time. This design inherently restricts the understanding of long-term outcomes and effectiveness of each screening method.
- **Sample Size and Representativeness:** With a total of 140 participants, the sample size may not be large enough to detect small differences between the two methods or to ensure that the findings are generalizable to a broader population. Moreover, the sample may not fully represent all demographic groups, particularly those from varying socioeconomic backgrounds or geographical regions, which could influence the prevalence and detection of cervical lesions.
- **Statistical Power:** The lack of statistically significant results in some comparisons, such as the odds ratios for detection rates and sensitivity, could be due to insufficient statistical power. This may prevent the detection of potentially important differences between the two methods.
- **Confounding Variables:** Although efforts were made to control for confounding variables, there may still be factors that were not accounted for that could affect the outcomes, such as participants' sexual history, HPV vaccination status, or previous screening history.
- **Technological Variability:** The study assumes that all LBC and Conventional Pap Smear procedures were performed with consistent technique and accuracy. However, variability in how samples are collected, processed and interpreted could influence the results. This includes potential differences in the skill level of the cytotechnologists and pathologists involved.
- **Economic Analysis:** While the study touches on cost-effectiveness, it does not provide a detailed economic analysis to fully assess the financial implications of replacing Conventional Pap Smear with LBC, particularly in resource-limited settings. Detailed cost-benefit analyses would be crucial to inform policy decisions.
- **Biases and Errors:** The potential for selection bias, information bias and measurement errors cannot be entirely ruled out. For instance, selection bias could occur if individuals who are more likely to participate in screening are also those with better health awareness or access to healthcare resources.

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