Original Research Article

https://doi.org/10.53339/aimdr.2026.12.5.4
E-ISSN: 2395-2822 | P-ISSN: 2395-2814

Diagnostic Performance of Colposcopy in Detecting CIN2+ Cervical Lesions Compared with Histopathology Following LEEP: A Hospital-Based Cross-Sectional Study

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ABSTRACT

Introduction: Cervical cancer typically arises from identifiable precancerous lesions, making the precise detection of clinically relevant CIN2+ lesions crucial for suitable therapy. Colposcopy is extensively employed for assessing screen-positive or clinically concerning cervical lesions, although its diagnostic efficacy differs across various environments.

Aim of the Study: The aim of this research was to assess the diagnostic efficacy of colposcopy in identifying CIN2+ cervical lesions in comparison to histopathological analysis post-LEEP.

Methods & Materials: This prospective observational study on diagnostic accuracy was carried out at a 250-bed general hospital in Jashore, Bangladesh, spanning six months from July 2025 to December 2025. A cohort of 100 women who received colposcopic assessment prior to LEEP was incorporated. The colposcopic assessment was classified as normal/benign, low-grade lesion/CIN1, high-grade lesion/CIN2-CIN3, or potentially invasive cancer. For diagnostic evaluation, high-grade lesions/CIN2-CIN3 and questionable invasive cancer were categorized as colposcopy CIN2+ positive. Histopathological examination following LEEP was deemed the benchmark, with CIN2, CIN3, and invasive cancer categorized as the presence of histopathological CIN2+. The calculations for sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were performed.

Results: Out of 100 patients, colposcopy identified 63.0% as CIN2+ positive, but histopathology validated CIN2+ disease in 8.0%. The diagnostic table indicated 7 true positives, 56 false positives, 1 false negative, and 36 true negatives. Colposcopy exhibited a sensitivity of 87.5%, specificity of 39.1%, positive predictive value of 11.1%, negative predictive value of 97.3%, and diagnostic accuracy of 43.0%.

Conclusion: Colposcopy demonstrated elevated sensitivity and substantial negative predictive value for identifying CIN2+ lesions, indicating effective rule-out capability. Nevertheless, diminished specificity and low positive predictive value suggest that affirmative colposcopic evaluations often exaggerate the presence of CIN2+ pathology and necessitate validation through histopathological examination post-LEEP.

Keywords: LEEP, cervical intraepithelial neoplasia, histopathology, colposcopy, CIN2+

Introduction

Cervical cancer continues to be a significant avoidable neoplasm in women, especially prevalent in low- and middle-income nations. The World Health Organization indicated that cervical cancer ranked as the fourth most prevalent cancer among women worldwide, with around 660,000 new diagnoses and 350,000 fatalities in 2022; around 94% of these fatalities transpired in low- and middle-income nations.[1–3] Chronic infection with oncogenic human papillomavirus is the primary factor in cervical cancer development, typically progressing through an identifiable premalignant stage.[4,5] This extended preinvasive phase allows for screening, diagnosis, and intervention prior to the advancement to invasive cancer. The identification and prompt management of precancerous cervical lesions are crucial for preventing cervical cancer, especially in environments where delayed diagnosis and restricted access to advanced cancer therapy pose significant public health issues. In Bangladesh, cervical cancer is a significant health challenge for women. GLOBOCAN 2022 recognized cervical cancer as one of the predominant malignancies affecting women in Bangladesh, with both national and regional statistics demonstrating that cervical precancer and invasive conditions continue to be significant concerns for women utilizing screening and gynecological treatments.[6] Evidence from hospitals in Bangladesh further substantiates this apprehension. In a tertiary-care investigation conducted in Rajshahi involving 1,000 VIA-positive cervical lesion patients, Naznin et al. documented histological results indicating CIN-I in 16.4%, CIN-II in 2.2%, CIN-III in 7.1%, and cervical cancer in 5.3% of the instances.[7] Similarly, Khanam et al. observed a crude CIN frequency of 5.84% in Khulna Division, including CIN-II in 1.1% and CIN-III in 0.73% on colposcopy-directed biopsy.[8] These findings reveal that screen-positive Bangladeshi women include a measurable proportion with clinically relevant precancerous lesions. Among cervical precancerous lesions, CIN2+ is often utilized as a clinically relevant diagnostic threshold since it encompasses CIN2, and CIN3 categories that usually require treatment or close clinical management. Precise recognition of CIN2+ is crucial to prevent the inadequate management of high-grade diseases and the unwarranted treatment of low-grade or benign illnesses. In many hospital-based approaches, women with positive VIA, abnormal cytology, recurring low-grade findings, or questionable cervical appearance are referred for colposcopic assessment. Colposcopy facilitates an enlarged visual examination of the cervix following the application of acetic acid and/or iodine, assisting healthcare providers in recognizing atypical transformation-zone alterations and directing biopsy or excisional interventions. However, colposcopy is an observer-dependent procedure, and its diagnostic accuracy may vary according to lesion visibility, transformation-zone type, menopausal status, inflammation, adequacy of examination, and operator experience. Published diagnostic accuracy studies show that the performance of colposcopy for CIN2+ detection is variable. In Bhutan, Dorji et al. evaluated colposcopy against histologic CIN2+ and reported overall sensitivity of 66.67%, specificity of 73.73%, and accuracy of 72.24%.[9] In China, Li et al. found that high-grade colposcopic impression of CIN2+ was associated with oncogenic HPV, and concluded that colposcopic impressions provide important clues for identifying CIN2+.[10] Another Chinese study among women with transformation zone type 3 reported CIN2+ prevalence of 11.0%, with colposcopy sensitivity of 51.2%, specificity of 96.5%, positive predictive value of 64.2%, and negative predictive value of 94.1%.[11] In western Kazakhstan, Balmagambetova et al. reported that colposcopy sensitivity for CIN2+ was 56.6% and specificity was 88.3%, with moderate agreement between colposcopy and histology.[12] Recent evidence from Bangladesh underscores the diagnostic capabilities and constraints of colposcopic scoring systems; Ferdous et al. determined that, with a cutoff of 5, Reid's colposcopic index exhibited a sensitivity of 37.0% and a specificity of 94.5%, whereas the Swede score

demonstrated a sensitivity of 74.1% and a specificity of 45.0% for predicting CIN2+ based on histopathology as the benchmark.[13] While colposcopy is extensively employed for assessing screen-positive or clinically concerning cervical lesions, its diagnostic efficacy varies among different demographics and clinical environments. Local hospital-derived evidence is essential to ascertain the efficacy of colposcopic impression in identifying clinically relevant CIN2+ lesions relative to histology. Histopathological examination following LEEP offers a tissue-derived benchmark and for the direct evaluation of true positives, false positives, false negatives, and true negatives in colposcopic classifications. Consequently, the current investigation sought to assess the diagnostic efficacy of colposcopy in identifying CIN2+ cervical lesions in comparison to histopathology after LEEP among women utilizing a hospital-based cervical screening and treatment facility.

Methods & Materials

This was a prospective observational diagnostic accuracy study conducted at 250 Bedded General Hospital, Jashore, Bangladesh over a period of 6 months, from July 2025 to December 2025. The study included 100 women who attended the cervical screening and treatment service and underwent colposcopic evaluation followed by LEEP. Participants were enrolled using the predefined data collection sheet, which recorded sociodemographic, reproductive, clinical, colposcopic, and histopathological variables. The collected sociodemographic and reproductive variables included age group, residence, educational status, and parity category. Clinical variables included the primary indication for colposcopy or LEEP, such as HSIL/ASC-H cytology, LSIL/ASC-US cytology, positive VIA or persistent low-grade lesion, and suspicious cervix or visible lesion on speculum examination. Presenting symptoms were recorded as asymptomatic screen-detected status, persistent per-vaginal discharge, postcoital bleeding, intermenstrual bleeding, or postmenopausal bleeding. Colposcopy was considered the index test. Colposcopic impression was categorized as normal or benign, low-grade lesion/CIN1, high-grade lesion/CIN2-CIN3, or suspicious invasive carcinoma or unsatisfactory. For diagnostic performance analysis, colposcopy was classified as CIN2+ positive when the impression was high-grade lesion/CIN2-CIN3 or suspicious invasive carcinoma, and CIN2+ negative when the impression was normal/benign or low-grade lesion/CIN1. Histopathology after LEEP was considered the reference standard. Final histopathology was categorized as benign/chronic cervicitis, CIN1, CIN2, CIN3, or invasive carcinoma. Histopathology was classified as CIN2+ when the diagnosis was CIN2, CIN3, or invasive carcinoma, and CIN2+ absent when the diagnosis was benign/chronic cervicitis or CIN1. Data were entered and analyzed after completion of the dataset. Descriptive statistics were used to summarize baseline characteristics, clinical presentation, colposcopic findings, and histopathological findings. Categorical variables were presented as frequency and percentage. Diagnostic performance of colposcopy for detecting CIN2+ lesions was assessed using histopathology after LEEP as the reference standard. True positive, false positive, false negative, and true negative results were derived from the comparison between colposcopy CIN2+ classification and histopathology CIN2+ status. Sensitivity, specificity, positive predictive value, negative predictive value, diagnostic accuracy, and CIN2+ prevalence were calculated.

Results

Most participants were aged 30 to 49 years, with equal proportions in the 30 to 39 years and 40 to 49 years groups, each comprising 43.0% of the sample. Urban residents accounted for 67.0% of participants. Secondary education was the most frequent educational category, reported in 52.0%.

Most participants were parous, with 51.0% having parity 1 to 2 and 46.0% having parity ≥3. The main indication for colposcopy or LEEP was positive VIA or persistent low-grade lesion, present in 97.0% of cases. The most common symptom was persistent per-vaginal discharge, reported by 60.0% of participants [Table 1].

The most frequent colposcopic impression was high-grade lesion, CIN2/CIN3, observed in 58.0%, followed by low-grade lesion, CIN1, observed in 35.0%. On final histopathology, most cases were diagnosed as CIN1, 60.0%, followed by benign/chronic cervicitis, 32.0%. Histopathology-confirmed CIN2+ disease was found in 8.0% of participants [Table 2].

Among the 58 participants with high-grade colposcopic impression, 5 cases, 8.6%, were confirmed as CIN2+ on histopathology. Among the 5 participants with colposcopic suspicion of invasive carcinoma, 2 cases, 40.0%, were confirmed as CIN2+ or worse, including 1 invasive carcinoma. In contrast, among 35 participants with low-grade colposcopic impression, only 1 case, 2.9%, showed CIN2 on final histopathology. Overall, many participants with high-grade colposcopic impression were reported as benign/chronic cervicitis or CIN1 on histopathology [Table 3].

Colposcopy identified 7 of 8 histopathology-confirmed CIN2+ cases, giving a sensitivity of 87.5%. One CIN2+ case was missed by colposcopy, producing 1 false-negative result. Specificity was 39.1%, as 56 participants were colposcopy CIN2+ positive but histopathology CIN2+ negative. The PPV was low at 11.1%, while the NPV was high at 97.3%. Overall

Table 1: Sociodemographic, reproductive, and clinical characteristics of the study participants, $n = 100$

Variable	Category	Frequency, *n*	Percentage, %
Age group	<30 years	2	2.0
	30 to 39 years	43	43.0
	40 to 49 years	43	43.0
	≥50 years	12	12.0
Residence	Urban	67	67.0
	Rural	33	33.0
Educational status	No formal schooling	10	10.0
	Primary	27	27.0
	Secondary	52	52.0
	Higher secondary and above	11	11.0
Parity category	Nulliparous	3	3.0
	Para 1 to 2	51	51.0
	Para ≥3	46	46.0
Primary indication	Positive VIA or persistent low-grade lesion	97	97.0
	Suspicious cervix or visible lesion on speculum	2	2.0
	Mixed cytology indication	1	1.0
Symptoms	Asymptomatic, screen detected	25	25.0
	Persistent per-vaginal discharge	60	60.0
	Postcoital bleeding	8	8.0
	Intermenstrual bleeding	4	4.0
	Postmenopausal bleeding	3	3.0

Table 2: Distribution of colposcopic impression and final histopathology after LEEP, $n = 100$

Variable	Category	Frequency, *n*	Percentage, %
Colposcopic impression	Normal/benign	2	2.0
	Low-grade lesion, CIN1	35	35.0
	High-grade lesion, CIN2/CIN3	58	58.0
	Suspicious invasive carcinoma	5	5.0
Derived colposcopy CIN2+ classification	CIN2+ positive	63	63.0
	CIN2+ negative	37	37.0
Final histopathology after LEEP	Benign/chronic cervicitis	32	32.0
	CIN1	60	60.0
	CIN2	6	6.0
	CIN3	1	1.0
	Invasive carcinoma	1	1.0
Derived histopathology CIN2+ status	CIN2+ present	8	8.0
	CIN2+ absent	92	92.0

Table 3: Cross-tabulation of colposcopic impression with final histopathology after LEEP, $n = 100$

Colposcopic impression	Benign/chronic cervicitis	CIN1	CIN2	CIN3	Invasive carcinoma	Total
Normal/benign	0	2	0	0	0	2
Low-grade lesion, CIN1	11	23	1	0	0	35
High-grade lesion, CIN2/CIN3	21	32	4	1	0	58
Suspicious invasive carcinoma	0	3	1	0	1	5
Total	**32**	**60**	**6**	**1**	**1**	**100**

Table 4: Diagnostic performance of colposcopy for detecting CIN2+ lesions using histopathology after LEEP as the reference standard, $n = 100$

A: Two-by-two diagnostic table			
Colposcopy CIN2+ classification	**Histopathology CIN2+ present**	**Histopathology CIN2+ absent**	**Total**
Colposcopy CIN2+ positive	7	56	63
Colposcopy CIN2+ negative	1	36	37
Total	**8**	**92**	**100**
B: Diagnostic indices			
Diagnostic index	**Estimate (%)**	**95% CI**	
Sensitivity	87.5	47.3 to 99.7	
Specificity	39.1	29.1 to 49.9	
Positive predictive value, PPV	11.1	4.6 to 21.6	
Negative predictive value, NPV	97.3	85.8 to 99.9	
Diagnostic accuracy	43.0	33.1 to 53.3	
Histopathology CIN2+ prevalence	8.0	3.5 to 15.2	

diagnostic accuracy was 43.0%. These findings indicate that colposcopy had high ability to rule out CIN2+ when negative, but positive colposcopic findings frequently overestimated CIN2+ disease compared with final histopathology after LEEP [Table 4].

Discussion

The present prospective observational diagnostic accuracy study evaluated colposcopy for detecting CIN2+ cervical lesions using histopathology following LEEP as the reference standard. Among 100 participants, histopathology-confirmed CIN2+ disease was present in 8.0%, while colposcopy classified 63.0% as CIN2+ positive. The derived diagnostic table showed 7 true positives, 56 false positives, 1 false negative, and 36 true negatives. Colposcopy showed high sensitivity, 87.5%, and high negative predictive value, 97.3%, but low specificity, 39.1%, low positive predictive value, 11.1%, and overall diagnostic accuracy of 43.0%. These findings suggest that colposcopy was useful for ruling out CIN2+ when negative, but positive colposcopic impressions frequently overestimated disease severity compared with final histopathology. The CIN2+ prevalence of 8.0% in the present study is close to the Bangladesh-based study by Ferdous et al., where colposcopic scoring systems were evaluated against histopathology among women with abnormal cervical screening results.[13] Their Swede score at cutoff 5 showed sensitivity 74.1%, specificity 45.0%, PPV 11.8%, and NPV 94.6%. This pattern is comparable to the present study, where sensitivity was 87.5%, specificity 39.1%, PPV 11.1%, and NPV 97.3%. The similarity suggests that in local referred or tertiary-care screening populations, colposcopic positivity may be sensitive but insufficiently specific for confirming CIN2+ disease, especially when the underlying histopathology-confirmed CIN2+ prevalence is low. The high sensitivity observed in this study is also consistent with the Bangladesh-based study by Bakshi et al., which assessed VIA-positive women by colposcopy and histopathology and reported colposcopy sensitivity 87.87% and specificity 55.55%.[14] The sensitivity in that study was almost identical to the present finding of 87.5%, supporting the interpretation that colposcopy may perform well as a rule-out test in screen-positive clinical pathways. However, both studies showed modest or low specificity, indicating that positive visual impressions require histopathological confirmation before final diagnostic interpretation. The present findings also align with the threshold-dependent pattern described by Qin et al. in a systematic review and meta-analysis of colposcopic accuracy.[15] That review found that when colposcopy was used to detect LSIL+ lesions, pooled sensitivity was high at 0.92, but specificity was low at 0.51. In contrast, for HSIL+ detection, pooled sensitivity decreased to 0.68, while specificity increased to 0.93. The present study's high sensitivity, 87.5%, and low specificity, 39.1%, suggest that the applied colposcopic threshold behaved more like a sensitive, inclusive visual threshold, increasing detection of possible disease but also increasing false-positive classification. Compared with several international studies, the specificity and PPV in the present study were lower. Dorji et al., in Bhutan, reported sensitivity 66.67%, specificity 73.73%, and accuracy 72.24% for histologic CIN2+ detection.[9] Li et al., in China, reported CIN2+ prevalence 11.0%, sensitivity 51.2%, specificity 96.5%, PPV 64.2%, and NPV 94.1% among women with transformation zone type 3.[11] Similarly, Li et al. reported colposcopy accuracy 87.4%, sensitivity 50.5%, and specificity 93.7% for CIN2+ detection among women with oncogenic HPV.[10] Compared with these studies, the present study had higher sensitivity but substantially lower specificity, PPV, and accuracy. These differences may reflect variations in study population, referral criteria, HPV status, transformation-zone type, colposcopic threshold, operator interpretation, and whether the reference standard was biopsy-based or LEEP histopathology. The low PPV of 11.1% is an important finding. Only 7 of 63 colposcopy CIN2+ positive cases were confirmed as CIN2+ on histopathology. This is partly explained by the low CIN2+ prevalence

of 8.0% and the large number of false-positive cases, 56. Histopathology showed that 32.0% of participants had benign/chronic cervicitis and 60.0% had CIN1, meaning that most participants did not have CIN2+ disease despite the high colposcopy-positive rate. Inflammation, immature metaplasia, acetowhite changes, and subjective visual interpretation may contribute to overestimation of disease severity on colposcopy. The high NPV of 97.3% was the strongest diagnostic finding. Among 37 participants classified as colposcopy CIN2+ negative, 36 were also CIN2+ negative on histopathology. This supports the clinical value of a negative or low-grade colposcopic impression for excluding CIN2+ disease. Similar high NPV was reported by Ferdous et al., with NPV 94.6% for Swede score cutoff 5, and by Li et al., with NPV 94.1%. Therefore, while a positive colposcopic impression had limited confirmatory value in the present study, a negative result was generally reliable for ruling out CIN2+.[10,13] The cross-tabulation further supports this interpretation. Among 58 participants with high-grade colposcopic impression, only 5 cases, 8.6%, were confirmed as CIN2+ on histopathology. Among 5 participants with suspected invasive carcinoma on colposcopy, 2 cases, 40.0%, were confirmed as CIN2+ or worse, including 1 invasive carcinoma. Conversely, among 35 participants with low-grade colposcopic impression, only 1 case, 2.9%, showed CIN2. This indicates that higher colposcopic severity was associated with higher CIN2+ proportion, but histopathological confirmation remained much lower than visual impression. Overall, the present study shows that colposcopy had strong rule-out performance for CIN2+ lesions, reflected by sensitivity 87.5% and NPV 97.3%, but weak rule-in performance, reflected by specificity 39.1% and PPV 11.1%. These findings support the continued use of colposcopy as a triage and assessment tool, but also emphasize that positive colposcopic CIN2+ impressions should be interpreted cautiously and confirmed by histopathology following LEEP.

Limitations of the Study

This study was conducted in a single hospital-based setting with a relatively small sample size, so the findings may not be generalizable to all screening populations. Colposcopic impression is operator-dependent, and inter-observer variability could not be assessed. In addition, the study evaluated diagnostic performance using categorical colposcopic impression rather than a standardized colposcopic scoring system.

Conclusion

In this prospective observational diagnostic accuracy study, colposcopy showed high sensitivity, 87.5%, and high negative predictive value, 97.3%, for detecting CIN2+ cervical lesions when compared with histopathology following LEEP. However, specificity was low, 39.1%, and positive predictive value was also low, 11.1%, indicating that positive colposcopic CIN2+ impressions frequently overestimated disease severity. Histopathology-confirmed CIN2+ disease was present in 8.0% of participants. These findings suggest that colposcopy is useful as a rule-out tool for CIN2+ lesions, but positive colposcopic findings should be confirmed by histopathology before final diagnostic or therapeutic decisions.

Ethical Approval

The study was approved by the Institutional Ethics Committee.

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How to cite this article: Foara HS, Zaman F, Akhter N, Diagnostic Performance of Colposcopy in Detecting CIN2+ Cervical Lesions Compared with Histopathology Following LEEP: A Hospital-Based Cross-Sectional Study. Ann. Int. Med. Den. Res. 2026;12(5):26–33.

Source of Support: Nil, **Conflict of Interest:** None declared

Received: 31-Jul-26; **Revised:** 15-Aug-26;
Acceptance: 27-Aug-26; **Published:** 15-Oct-26