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Research Article

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Assessment of Colposcopy Accuracy as Predictors of High-Grade Histology Outcomes in Large Loop Excision of the Transformation Zone: 12 Months Retrospective Analysis

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ABSTRACT
Introduction: This study evaluated the diagnostic accuracy of colposcopic assessment and the effectiveness of large loop excision of the transformation zone (LLETZ) in the management of cervical intraepithelial neoplasia (CIN) within a tertiary UK centre.

Methodology: A retrospective review was conducted of 284 consecutive women who underwent colposcopy and LLETZ at Addenbrooke's Hospital, Cambridge, between 1 January and 31 December 2023. Primary outcomes included adequacy of excision depth, histological margin status, and Test-of-Cure (TOC) outcomes. Depth adequacy was defined according to transformation zone (TZ) type (TZ1 ≥7 mm, TZ2 ≥10 mm, TZ3 ≥15 mm). Demographic and clinical characteristics were recorded.

Results: Of the 284 LLETZ procedures, 87.7% were performed as a single excisional specimen, meeting national quality standards. TOC success was achieved in 89% of cases. The positive predictive value of colposcopy for detecting high-grade histology was 82.5% among women referred with high-grade cytology and 69% overall. Adequate excision depth was achieved in 59% of cases, with the highest adequacy observed in Type 1 transformation zones (64%). Complete excision with negative margins was achieved in 61.4% of cases, with lower rates observed in Type 2 and Type 3 transformation zones. Margin positivity was more frequent among younger women aged 25–34 years.

Conclusion: Colposcopy and LLETZ demonstrated high diagnostic accuracy and effective disease clearance in this tertiary centre. While overall outcomes aligned with national standards, achieving adequate excision depth and negative margins-particularly in Type 3 transformation zones-remains challenging. A cautious, individualised surgical approach may help balance oncological safety with fertility preservation while maintaining high TOC success.

Keywords: Lletz, Large Loop Excision of the Transformation Zone, Cervical Intraepithelial Neoplasia (Cin), Test-Of-Cure, Transformation Zone, Adequacy, Performance Index

Colposcopy Accuracy and LLETZ Effectiveness in Cervical Intraepithelial Neoplasia Treatment

Introduction

Cervical cancer remains a major global health challenge, ranking as the fourth most common malignancy to affect women worldwide [1]. In 2020, an estimated 604,000 new cases and 342,000 deaths worldwide were reported [2,3] . More recent estimates suggest that in 2022 there were approximately 660,00 incident cases resulted in 350,000 deaths worldwide in 2022 [4]. Highlighting the persistent and substantial global burden of disease [5,6]. Persistent infection with oncogenic human papillomavirus types is unequivocally recognized as the primary cause of nearly all cervical cancers [7-9].

Cervical intraepithelial neoplasia, the precancerous cindition that precedes invasive cervical cancer, is highly amenable

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to early detection and treatment [7-11]. This underscores the critical need for robust diagnostic and therapeutic protocols. Colposcopy plays a central role in diagnosis, enabling magnified visualization of the cervix, vagina, and vulva to identify abnormal areas. However, the diagnostic accuracy of colposcopy in detecting high-grade cervical lesions allows for early detection and timely treatment [12,13]. Despite these limitations, colposcopy remains an indispensable component of effective management and prevention of invasive cervical cancer.

Large Loop Excision of the Transformation Zone is a widely recognized and effective therapeutic modality for high grade CIN, offering both diagnostic and curative benefits [14,15]. Optimizing patient outcomes through accurate diagnosis and effective treatment alligns with global cervical cancer elimination strategies, particularly those outlined by the World Health Organization [2,16,17,].

This study evaluates the performance of colposcopy and LLETZ within a real-world clinical setting. Specifically, we examine the diagnostic accuracy of colposcopy assessment and the effectiveness of LLETZ in treating CIN (cervical intraepithelial neoplasia) among women in Cambridgeshire, United Kingdom, benchmarking outcomes against national standards by the British Society for Colposcopy and Cervical Pathology (BSCCP) . Key indicators include rates of complete excision, test-of-cure failure, and adequacy of histological margins, and the influence of patient characteristics. By providing insights into the factors that impact CIN management, this study contributes to refinement of screening programs and treatment protocols, ultimately supporting effects to prevent progression to invasive cervical cancer [7].

Literature Review

Cervical cancer remains a leading cause of cancer-related morbidity and mortality among women, ranking fourth most frequently diagnosed malignancy worldwide [18]. Most national prevention programmes rely on cervical cytology and/or human papillomavirus (HPV) testing, with colposcopy used as a secondary triage test when screening identifies abnormal finding [13].

The disproportionate burden of cervical cancer in low and middle-income countries, where the majority of deaths occur, underscores persistent inequalities in healthcare access and outcomes [17,19,20,]. In recognition of this, the World Health Organization launched a global strategy to eliminate cervical cancer as a public health problem by 2030, setting targets for HPV vaccination, cervical screening, and treatment coverage [2,16,17,21-24,].

Secondary prevention through organised screening programmes remains the cornerstone of cervical cancer control. Cytology and HPV-based testing enable the early detection and treatment of cervical intraepithelial neoplasia (CIN) before malignant transformation occurs [7-25]. The integration of HPV testing into screening protocols has significantly improved sensitivity for detecting high-grade CIN (CIN2+ and CIN3+), providing stronger protection against invasive cervical carcinoma than cytology alone [17,26,27]. However, despite these advancements, implementation challenges – particularly in achieving adequate population coverage, follow-up, and access to colposcopy – persist globally, especially in resource-limited settings [16].

Colposcopy remains central to the diagnostic pathway, allowing magnified visualisation of the cervix, vagina, and vulva to guide targeted biopsies and confirm histopathological diagnoses [11-28]. Although indispensable for early detection, its diagnostic accuracy is limited by subjectivity and variability related to the examiner's experience, lesion visibility, and examination quality [13,29-31]. Reported sensitivities for detecting CIN2+ range between 61.5% to 98.3%, with specificities between 35.3% to 84.2% [25,32-34]. Moreover, colposcopy may miss a substantial proportion of high-grade squamous intraepithelial lesions [35]. The International Federation of Cervical Pathology and Colposcopy (IFCPC) introduced a standardised terminology system in 2011 to enhance consistency and diagnostic reliability, yet evidence regarding its impact remains mixed, highlight the need for continued evaluation [36].

Large Loop Excision of the Transformation Zone (LLETZ) represents a cornerstone in the therapeutic management of CIN. The technique facilitates both diagnosis and treatment by excising abnormal cervical tissue within the transformation zone, thereby removing dysplastic tissue while enabling histopathological assessment [14,15]. LLETZ is generally safe and effective, with clearance rates ranging from 70% to 97% across diverse clinical settings [14-37]. Nevertheless, incomplete excision, particularly in large endocervically extending lesions, remain a significant predictor of residual or recurrent disease [14,38-40]. Outcomes are influenced by factors such as excision technique, specimen volume, and transformation zone type, which together determine the adequacy of both diagnostic yield and therapeutic effect [41,42].

The natural history of HPV infection reveals that most infections, particularly those resulting in low-grade CIN, regress spontaneously, especially among younger women [7,43-45]. However, persistent infection with high-risk HPV types significantly increase the risk of progression to high-grade lesions and invasive cancer [7-46]. These insights emphasis the importance of distinguishing lesions requiring interventions from those likely to regress, to balance effective treatment with the avoidance of overtreatment.

While substantial literature supports the efficacy of colposcopy and LLETZ, real-world performance can vary depending on local practices, population characteristics, and service delivery factors [35]. Margin status remains a critical determinant of treatment success [47] and studies indicate that demographic and anatomical factors, such as younger age or type 3 transformation zones, may predispose to incomplete excision or margin positivity [48-50].

This study seeks to address these knowledge gaps by evaluation colposcopy accuracy and LLETZ effectiveness in the management of CIN within a real-world clinical setting in Cambridgeshire, United Kingdom. Through analysis of key outcomes measures, including complete excision rates, test-of-cure results, histological margin status, and patient factors such as age and transformation zone type, this research contributes to the ongoing refinement of

CIN management strategies. By integrating these findings into the broader context of cervical cancer prevention, this study supports the optimisation of diagnostic and therapeutic pathways aligned with global elimination of cervical cancer [2,7,17,].

Materials and Methods

Study Design and Setting

This retrospective observational study analysed a consecutive cohort of women who underwent colposcopy at Addenbrooke's Hospital, Cambridge University Hospitals NHS Foundation Trust, United Kingdom. The study period spanned from 1 January 2023 to 31 December 2023. Addenbrooke's Hospital is a tertiary referral center serving a large and demographically diverse population across Cambridgeshire and the surrounding region. The study aimed to evaluate the diagnostic accuracy of colposcopy and the therapeutic effectiveness of Large Loop Excision of the Transformation Zone (LLETZ) in the management of cervical intraepithelial neoplasia (CIN).

Study Population

A total of 284 consecutive patients who underwent colposcopic assessment within the study period were identified through the hospital's electronic colposcopy database. Eligible participants were those who had both a colposcopy and a subsequent LLETZ procedure performed within the defined timeframe, ensuring inclusion of patients for whom both diagnostic and therapeutic data were available.

Patients were excluded if they:

- Did not undergo LLETZ following colposcopic evaluation,
- Had incomplete or missing histopathological data, or
- Moved out of the region or were lost to follow-up before their Test-of-Cure (TOC) visit.

This approach ensured a robust dataset representing the complete clinical pathway from initial diagnosis to post-treatment surveillance.

Data Collection and Variables

Data were extracted retrospectively from electronic patient records, including demographic, clinical, and histopathological information. Variables collected included:

- Demographic characteristics: age, body mass index (BMI), parity, menopausal status, smoking status, and HPV vaccination status.
- Referral cytology results: categories based on the UK NHS Cervical Screening Programme classification.
- Colposcopic findings: transformation zone (TZ) type (TZ1–TZ3), impression grade (low-grade, high-grade, or suspicious of invasion), and lesion characteristics.
- Histopathological outcomes: LLETZ specimen diagnosis, excision margin status (complete vs. incomplete), and grade of CIN.
- Follow-up data: Test-of-Cure cytology and HPV results, recurrence or persistence of CIN, and subsequent management steps.

To evaluate factors influencing treatment outcomes, patient characteristics such as smoking status, menopausal state, and BMI were assessed for potential associations with incomplete excision and TOC failure.

Population Characteristics

The final cohort demonstrated broad demographic variation reflective of a real-world colposcopy population:

- Parity: 87 (30.6%) nulliparous; 197 (69.4%) multiparous.
- Smoking status: 65 (22.9%) current smokers; 219 (77.1%) non-smokers.
- Menopausal status: 80 (28.2%) postmenopausal; 204 (71.8%) premenopausal.
- HPV vaccination status: 30 (10.6%) vaccinated; 254 (89.4%) unvaccinated.
- Age: median 39 years (interquartile range 33–46); mean 42.3 years (range 24–78).
- Body Mass Index: mean 27.0 kg/m² (SD 4.8).

Ethical Considerations

This project was registered and approved with the Cambridge University Hospitals NHS Foundation Trust Clinical Audit Department as a service evaluation. It was conducted in accordance with the Health Research Authority (HRA) decision-making framework, confirming that formal research ethics committee approval was not required.

All data were collected and analyzed under institutional audit governance policies and handled in compliance with the General Data Protection Regulation (GDPR) and the Data Protection Act 2018. Patient confidentiality was maintained throughout, with all identifiable information anonymized prior to analysis. The study adhered to the principles of the Declaration of Helsinki and the NHS Code of Practice for Clinical Audit.

Outcome Measures and Standards

The primary objective of this study was to evaluate departmental performance in colposcopic diagnosis and LLETZ treatment against national benchmarks established by the British Society for Colposcopy and Cervical Pathology (BSCCP) and the NHS England guidelines on Colposcopic Diagnosis, Treatment and Follow-up [51]. Key performance indicators (KPIs) were assessed to determine diagnostic accuracy, procedural adequacy, and overall quality of care. These included:

- Positive predictive value for high-grade lesion colposcopic diagnosis: >65%.
- Biopsies suitable for histological interpretation: >90%.
- Specimens removed in a single excisional sample: >80%.
- Adequacy of LLETZ depth: >95%.

These standards provided the framework for evaluating both the accuracy of colposcopic impression and the effectiveness of LLETZ as a therapeutic procedure.

The primary outcome measures were:

- **Rate of complete excision,** defined as histologically confirmed negative margins (no CIN at excision margins).
- **Test-of-Cure (TOC) failure,** defined as persistence of high-risk HPV infection and/or abnormal cytology at follow-up.
- **Adequacy of excision depth,** stratified by transformation zone type.
- Secondary outcomes included the positive predictive value of colposcopic assessment for high-grade disease (CIN2+) and the proportion of specimens obtained as single, intact excision samples.

Histological Assessment and Depth Criteria
Histopathological examination of excised specimens was performed by consultant histopathologists according to standardized departmental and BSCCP protocols. Each specimen was assessed for grade of CIN, margin status, and depth of excision. Margins were categorized as:

- **Negative:** complete excision of the CIN lesion with histologically clear margins.
- **Positive:** presence of CIN at one or more resection margins, indicating incomplete excision.

To ensure consistent evaluation of excision adequacy, minimum depth thresholds were defined according to the transformation zone (TZ) type observed at colposcopy:

- **Type 1 TZ:** ≥7 mm
- **Type 2 TZ:** ≥10 mm
- **Type 3 TZ:** ≥15 mm

These thresholds were adopted in line with BSCCP and NHS England guidance to reflect the varying anatomical complexity and glandular extension associated with different TZ types.

The positive predictive value (PPV) of colposcopy for detecting histologically confirmed high-grade lesions (CIN2 or higher) was calculated as the proportion of patients with a high-grade colposcopic impression who were found to have high-grade CIN on final histology.

Statistical Analysis
All statistical analyses were conducted using SPSS Statistics software. Descriptive statistics were used to summarise baseline demographic and clinical characteristics, expressed as frequencies and percentages for categorical variables and as means with standard deviations or medians with interquartile ranges for continuous variables, depending on data distribution. Comparative analyses were performed to explore associations between patient characteristics (e.g., age, parity, menopausal status, smoking status, BMI, transformation zone type) and treatment outcomes (e.g., incomplete excision, TOC failure). Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate, while continuous variables were compared using the independent samples t-test or Mann–Whitney U test.

Statistical significance was defined as $p < 0.05$ (two-tailed). Missing data were handled through case-wise deletion, with sample sizes adjusted accordingly for each analysis.

Quality Assurance and Data Validation
To ensure data integrity and reliability, a multi-step quality assurance process was implemented. All data were independently extracted and verified by two investigators to minimize transcription and classification errors. Any discrepancies identified between data sources were resolved through cross-referencing with original electronic medical records, histopathology reports, and colposcopy documentation within the hospital's digital records system.

Colposcopic impressions and histopathological diagnoses were reviewed in accordance with BSCCP standards. Random cross-audits of 10% of the dataset were performed to validate data accuracy and consistency. Histological margin classifications and excision depth measurements were re-evaluated by a consultant histopathologist blinded to the original findings to confirm reliability and inter-observer consistency.

All procedures were conducted in line with institutional audit governance frameworks. The anonymized dataset was stored on secure, password-protected NHS servers accessible only to the study team. Data handling and reporting adhered to the General Data Protection Regulation (GDPR) and NHS Digital Data Security and Protection Toolkit standards.

Findings
This section presents the key findings from our analysis of colposcopy cases and LLETZ procedures.

Baseline Population Characteristics
A total of 284 patients who underwent colposcopy and LLETZ between January and December 2023 were included in the analysis. The majority of referrals were due to high-grade cytology, which represented the most frequent indication for colposcopic assessment. Referrals for glandular neoplasia and suspected malignancy were least common (Table 1).

Table 1: Referral Cytology Distribution

Referral cytology	Number	Percentage
Negative	64	22.5%
Borderline	28	9.8%
Low grade	33	11.6%
High grade moderate	60	21.1%
High grade severe	95	33.3%
Cancer	05	1.8%

Among all patients, 187 (65.8%) underwent therapeutic LLETZ procedures, while 98 (34.2%) had diagnostic LLETZ.

Colposcopic assessment revealed that Type 1 transformation zones (TZs) were the most prevalent (53.7%), followed by Type 2 TZs (26.0%) and Type 3 TZs (20.4%) (Table 2).

Table 2: Types of Transformation Zones Identified at Colposcopy

Type of tz	Numbers
TYPE 1	153
TYPE 2	74
TYPE 3	58

Colposcopic impressions varied, with high-grade changes representing the majority of cases (Table 3).

Table 3: Colposcopic Impressions

Colposcopic Impression	Numbers
Low grade/hpv changes	62
High grade	147
Cancer	4

Normal	16
Unsatisfactory	56

Table 4: Lletz Outcomes Benchmarked Against Bsccp Performance Standards

	Observed	BSCCP Standard
PPV high-grade	82.5%	>65%
Single-piece excision	87.7%	>80%
Specimen adequacy	98.2%	>90%
Depth adequacy	59%	≥95%

Table 4 summarises key performance indicators for colposcopic diagnosis and large loop excision of the transformation zone (LLETZ) in the study cohort, benchmarked against national performance standards set by the British Society for Colposcopy and Cervical Pathology (BSCCP). Outcomes include the positive predictive value (PPV) of colposcopic assessment for high-grade disease, the proportion of procedures performed as a single excisional specimen, specimen suitability for histopathological interpretation, and adequacy of excision depth according to transformation zone–specific criteria.

Lletz Procedure Outcomes

A total of 87.7% of LLETZ procedures were completed in a single excisional sample, surpassing the national benchmark of 80%, indicating procedural proficiency. The overall Test-of-Cure (TOC) success rate—defined as negative cytology and HPV at follow-up—was 89%.

Among patients with available TOC data, 73 remained HPV positive and 126 were HPV negative. Repeat LLETZ was required in 35 cases (12.3%), and 5 patients (1.8%) were diagnosed with invasive carcinoma. Negative LLETZ histology was observed in 46 cases (16.2%).

Test-of-Cure Outcomes by Transformation Zone Type

TOC outcomes were analyzed according to transformation zone type and adequacy of excision depth (Tables 5).

Table 5. Test-of-Cure Outcomes According to Transformation Zone Type

Transformation Zone Type	Toc Negative n (%)	Toc Positive n (%)	P value*
Type 1 (n = 153)	44 (67.9)	19 (32.1)	0.84
Type 2 (n = 74)	10 (63.0)	10 (37.0)	0.15
Type 3 (n = 58)	16 (48.5)†	17 (51.5)†	NA‡

*Chi-square or Fisher's exact test comparing adequate vs inadequate excision depth within each transformation zone.

†Percentage calculated among cases with available Test-of-Cure data.

‡Statistical comparison not performed due to absence of cases with adequate excision depth in Type 3 transformation zones.

When stratified by transformation zone type, no statistically significant association was observed between excision depth adequacy and Test-of-Cure outcome for Type 1 or Type 2 transformation zones (Table 5). In Type 3 transformation zones, adequate excision depth was not achieved in any case, precluding formal statistical comparison. While overall depth adequacy remained below the BSCCP target (Table 4), marked variation was observed according to transformation zone type, with particularly poor performance in Type 3 transformation zones (Figure 1).

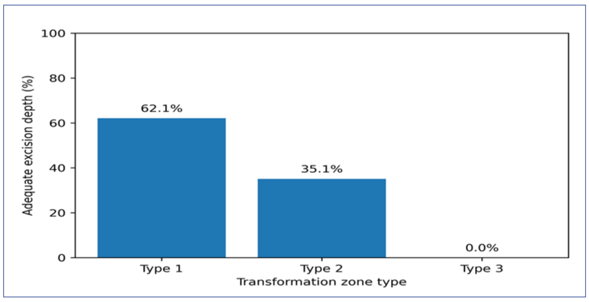

Figure 1: Excision Depth Adequacy by Transformation Zone Type

Figure 1: Proportion of large loop excision of the transformation zone (LLETZ) procedures achieving adequate excision depth stratified by transformation zone type. Adequate depth was defined according to BSCCP-recommended minimum depth thresholds.

Colposcopic Accuracy

The positive predictive value (PPV) of colposcopy for detecting high-grade histology (CIN2+) was 82.5% among referrals with high-grade cytology and 69% overall.

Colposcopy demonstrated a sensitivity of 76.5% and a specificity of 44.3%, indicating good diagnostic yield in identifying high-grade lesions but moderate discriminatory performance overall.

Excision Quality and Influencing Factors

Adequate excision depth-defined according to transformation zone–specific criteria—was achieved in 59% of cases. Adequacy was highest for Type 1 TZs, reflecting their greater procedural accessibility, and lowest for Type 3 TZs, which often presented technical challenges. Complete excision with histologically negative margins was achieved in 61.4% of cases (Table 6). Margins were cautherized so complete treatment rates would be higher

Table 6: Margin Status Following Excision

Margin status	Numbers
Positive	105
Negative	175
Not applicable	5

Histopathological Outcomes of LLETZ Specimens

Histological analysis of LLETZ specimens revealed that CIN3 was the most common diagnosis, followed by CIN2 and CIN1 (Table 7). Glandular neoplasia and invasive carcinoma were relatively rare findings.

Table 7: Histology of LLETZ Specimens

Histology	Numbers
CIN 1	49

CIN2	57
CIN3	108
CGIN	15
Cancer	5
Ungradable	5
Negative	46

Summary of Findings

In summary, this audit demonstrated strong departmental performance across key quality indicators of colposcopy and LLETZ procedures. The majority of excisions were achieved in a single sample, with a high overall Test-of-Cure success rate of 89%, reflecting effective procedural and follow-up practices. Colposcopy showed a robust positive predictive value for high-grade disease (82.5% among high-grade cytology referrals), consistent with national standards, though its specificity remained moderate. Adequate excision depth was achieved in 59% of cases, with the greatest adequacy observed in Type 1 transformation zones. Despite this, complete excision with negative margins was attained in only 61.4% of cases, underscoring persistent challenges in managing Type 3 transformation zones, where inadequate depth was universal and associated with lower Test-of-Cure success. These findings align with national data highlighting the technical difficulty of excising endocervical lesions and reinforce the importance of tailoring excision strategy to transformation zone anatomy to optimize treatment outcomes.

Discussion

This study provides important insights into the diagnostic performance of colposcopy and the therapeutic effectiveness of Large Loop Excision of the Transformation Zone (LLETZ) in the management of cervical intraepithelial neoplasia (CIN) at a tertiary centre in Cambridgeshire, United Kingdom. The results demonstrate strong adherence to BSCCP quality standards in several key domains while identifying specific areas for procedural refinement, particularly in relation to excision depth and margin status.

Effectiveness of LLETZ

The high Test-of-Cure (TOC) success rate observed in this cohort (89%) affirms the effectiveness of LLETZ in achieving disease clearance and aligns with outcomes reported in existing literature, which typically cite cure rates of 85–95% [15,48,52,53]. LLETZ remains a cornerstone of CIN management, balancing therapeutic efficacy with preservation of cervical integrity [54].

Consistent with prior studies, margin status and persistent HPV infection emerged as the most important predictors of residual or recurrent disease [39-55]. The overall negative margin rate in this study (61.4%) was modestly lower than the BSCCP target of ≥80%, and similar to other real-world series reporting negative margins in 60–70% of cases [56,57]. This reinforces that while LLETZ is highly effective, complete excision-particularly in women with endocervical extension-remains challenging.

Colposcopy Accuracy

The diagnostic performance of colposcopy in this cohort was consistent with national benchmarks. The positive predictive value (PPV) for high-grade histology was 82.5% among women referred with high-grade cytology, exceeding the BSCCP recommended threshold of >65% [51]. The overall PPV across all referrals (69%) and sensitivity of 76.5% compare favourably with previously published ranges [12,13,25].

Colposcopy's diagnostic variability remains well recognised, with accuracy influenced by examiner experience, lesion visibility, and transformation zone characteristics [30-58]. The moderate specificity observed in this cohort (44.3%) reflects the subjective nature of colposcopic grading, which has been widely reported in the literature [33-59]. These findings underscore the continued importance of structured training, adherence to IFCPC terminology, and periodic performance audits to enhance inter-observer consistency and diagnostic reliability.

Excision Quality and Influencing Factors

Overall departmental performance met or exceeded three of the four BSCCP quality standards, including positive predictive value for high-grade disease, single-piece excision rates, and specimen adequacy (Table 4). Although almost all LLETZ specimens (98.2%) were suitable for histopathological assessment, exceeding the BSCCP benchmark, adequacy of excision depth and margin clearance demonstrated room for improvement. Adequate excision depth was achieved in 59% of cases, with the greatest success observed in Type 1 transformation zones. In contrast, consistent inadequacy in Type 3 zones reflects the recognised technical challenges associated with endocervical lesions and is in keeping with findings from previous studies, and highlights the technical difficulty of achieving sufficient depth in such lesions [41,42].

Incomplete excision is a recognised risk factor for treatment failure and recurrent CIN [56,55]. Rates of positive margins in the present study (37%) are comparable to those reported internationally, where residual disease is more frequent at the endocervical margin [57-60]. This emphasises the need to individualise excision strategy based on transformation zone type and lesion extent.

Interestingly, an increased incidence of positive margins was noted among younger women (aged 25–34 years), a finding consistent with reports that age and lesion characteristics can influence surgical completeness [39,42,53]. This may relate to narrower cervical anatomy or higher-grade lesions in this demographic. Further prospective studies are warranted to elucidate the interplay between age, HPV persistence, and anatomical factors influencing incomplete excision.

Clinical Implications

The findings of this audit have several implications for clinical practice. First, the strong Test-of-Cure outcomes and high PPV support the ongoing use of LLETZ and colposcopy as effective components of the cervical screening pathway. However, the moderate rate of incomplete excisions suggests a need for enhanced procedural planning, particularly for Type 3 transformation zones. In selected patients, alternative excisional approaches, including cold knife conisation, endocervical mapping and extended loop depths may be appropriate, particularly when standard techniques are insufficient or margins are difficult to assess.

Second, the variability in colposcopic performance reinforces the importance of continued professional development and adherence to standardized terminology systems, as well as incorporating objective adjuncts such as computer-assisted colposcopy or digital image review to reduce observer bias.

Finally, these findings support ongoing quality assurance through regular departmental audits against BSCCP standards to ensure continuous improvement in diagnostic and therapeutic outcomes within cervical screening services.

Limitations

This study should be interpreted within the context of several limitations. Its retrospective design introduces potential biases inherent in secondary data analysis, including incomplete or missing records [61,62]. The single-centre setting limits generalizability, as variations in patient demographics and procedural expertise may influence results [63]. Additionally, data regarding HPV viral load, lesion size, and colposcopic image grading were unavailable, which could provide further insight into factors influencing margin status and recurrence risk [15-64]. The study also did not differentiate between persistent and recurrent disease, which may have implications for interpreting long-term outcomes [65].

Strengths

Despite these limitations, the study possesses several key strengths. It includes a large, consecutive sample of patients reflective of real-world practice, ensuring robust external validity [66]. Comprehensive data collection allowed for a multifactorial analysis of demographic and procedural factors influencing treatment outcomes. Conducted within an operational ESGO-accredited centre, this audit provides pragmatic evidence that directly informs quality improvement initiatives and supports adherence to national standards in colposcopic practice.

Conclusion

In conclusion, this study demonstrates that colposcopy and large loop excision of the transformation zone (LLETZ) remain highly effective for the diagnosis and management of cervical intraepithelial neoplasia (CIN) within a tertiary UK centre, with outcomes largely aligned with British Society for Colposcopy and Cervical Pathology (BSCCP) performance standards. Three of the four key performance indicators-including positive predictive value for high-grade disease, specimen suitability for histopathological interpretation, and single-piece excision rates-met national benchmarks set by BSCCP, confirming the sustained diagnostic utility of colposcopy and the effectiveness of established treatment protocols in routine clinical practice.

Nonetheless, the study highlights persistent challenges in achieving adequate excision depth and complete margin clearance, particularly in patients with Type 3 transformation zones. Although the target threshold for excision depth was not met, no statistically significant difference in treatment outcomes was observed between cases with adequate and inadequate depth, suggesting that clinical judgement and individualised surgical decision-making may play an important role. These findings are particularly relevant for younger women, where balancing oncological safety with fertility preservation remains a key consideration.

The results underscore the importance of tailoring excisional approaches to transformation zone anatomy, maintaining high standards of colposcopist training, and embedding routine performance audit within clinical services. Future research should focus on identifying factors contributing to margin positivity and evaluating emerging technologies for real-time intraoperative margin assessment, which may further improve surgical precision and reduce reliance on post-operative histopathology alone [67-69].

Overall, this study contributes valuable real-world evidence to ongoing cervical cancer prevention efforts. The World Health Organization has set ambitious targets for 2030, which include vaccinating 90% of girls against HPV, screening 70% of women with high-performance tests, and treating 90% of women diagnosed with precancerous lesions or cancer [21-24]. Achieving these goals necessitates a comprehensive approach that includes robust screening programs, effective treatment modalities, and continuous education for both healthcare providers and the public [70,71]. While developed countries have made significant strides, challenges persist in low- and middle-income countries, highlighting the critical need for accessible and affordable screening and treatment options, along with increased public awareness [72-74]. This study reinforces the ongoing commitment to improving the quality of care and advancing global strategies for cervical cancer prevention.

Reference

1. Sung, Hyuna, Jacques Ferlay, Rebecca L Siegel, et al. ‘Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries’. CA: A Cancer Journal for Clinicians. 2021. 71: 209-249.
2. Zhang, Wanting, Kai Gao, Freya Fowkes JI, et al. ‘Associated Factors and Global Adherence of Cervical Cancer Screening in 2019: A Systematic Analysis and Modelling Study’. Globalization and Health. 2022. 18: 101.
3. Scherer-Quenzer, Anne Cathrine, Jelena Findeis, Saskia-Laureen Herbert, et al. ‘The Value of Endocervical Curettage during Large Loop Excision of the Transformation Zone in Combination with Endocervical Surgical Margin in Predicting Persistent/Recurrent Dysplasia of the Uterine Cervix: A Retrospective Study’. BMC Women’s Health. 2024a. 24: 461.
4. IARC Global Cancer Observatory. Statistics at a Glance.’ Globoscan, February 8. 2024.
5. Li, Zhuang, Penglin Liu, Aijun Yin, et al. ‘Global Landscape of Cervical Cancer Incidence and Mortality in 2022 and Predictions to 2030: The Urgent Need to Address Inequalities in Cervical Cancer’. International Journal of Cancer. 2025. 157: 288-297.
6. Wu, Jie, Qianyun Jin, Yunmeng Zhang, et al. ‘Global Burden of Cervical Cancer: Current Estimates, Temporal Trend and Future Projections Based on the GLOBOCAN 2022’. Journal of the National Cancer Center. 2025. 5: 322-329.
7. Basu, Partha, Srabani Mittal, Diama Bhadra Vale, Youssef Chami Kharaji. ‘Secondary Prevention of Cervical Cancer’. Best Practice & Research Clinical Obstetrics & Gynaecology. 2018. 47: 73-85.

8. Bosch, Xavier F, Silvia de Sanjosé. 'The Epidemiology of Human Papillomavirus Infection and Cervical Cancer'. Disease Markers. 2007. 23: 213-227.
9. Walboomers, Jan MM, Marcel V Jacobs, Michele Manos M, et al. 'Human Papillomavirus Is a Necessary Cause of Invasive Cervical Cancer Worldwide'. The Journal of Pathology. 1999. 189: 12-19.
10. Armstrong GM, Ragupathy K. 'Test of Cure and beyond: Superiority of Thermal Ablation over LLETZ in the Treatment of High-Grade CIN'. Archives of Gynecology and Obstetrics. 2022. 306: 1815-1820.
11. Yao, Xiaoxi, Mingrong Qie, Leni Kang, et al. 'Assessing the Risk of Undetected Cervical Cancer in Women with a Biopsy of High-Grade Cervical Intraepithelial Neoplasia: Predictive Value of Cytology and Endocervical Curettage (ECC)'. BMC Cancer. 2025. 25: 1238.
12. Massad, Stewart L, Jose Jeronimo, Hormuzd A Katki, Mark Schiffman. 'The Accuracy of Colposcopic Grading for Detection of High-Grade Cervical Intraepithelial Neoplasia'. Journal of Lower Genital Tract Disease. 2009. 13: 137-144.
13. Bai, Anying, Jiaxu Wang, Qing Li, Samuel Seery, et al. 'Assessing Colposcopic Accuracy for High-grade Squamous Intraepithelial Lesion Detection: A Retrospective, Cohort Study'. BMC Women's Health. 2022. 22: 9.
14. Ivanova, Yonka, Yavor Kornovski, Stoyan Kostov, Stanislav Slavchev, et al. 'Prognostic Factors for Low- and High Grade Squamous Intraepithelial Lesions in Histological Preparations Following LLETZ Procedure'. Wiadomości Lekarskie. 2024. 77: 1562-1568.
15. Parker, Victoria L, Emma Long, Kay Ellis, Madeleine C Macdonald, et al. 'Predictors for Negative Large Loop Excision of the Transformation Zone (LLETZ) in a Primary HPV Screened Population'. Journal of Gynecology Obstetrics and Human Reproduction. 2025. 54: 102913.
16. Effah, Kofi, Ethel Tekpor, Comfort Mawusi Wormenor, et al. 'Expanding Management Strategies for Cervical Precancerous Lesions in Resource-Limited Settings: Insights from a Training Center in a District Hospital in Ghana'. BMC Women's Health. 2024. 24: 428.
17. Ellis LB, Bowden SJ, Lyons D, Kyrgiou M. The Royal College of Obstetricians and Gynaecologists. 2025. 'SIP 7: Progress in Cervical Cancer Prevention in the UK (2025 Second Edition)'. BJOG: An International Journal of Obstetrics & Gynaecology. 2025. 1471-0528.
18. Houghton SJ, Luesley DM. 'LLETZ — Diathermy Loop Excision'. Current Obstetrics and Gynaecology. 1995. 5: 107-109.
19. Chuang, Linus T, Sarah Temin, Rolando Camacho, et al. 'Management and Care of Women With Invasive Cervical Cancer: American Society of Clinical Oncology Resource-Stratified Clinical Practice Guideline'. Journal of Global Oncology. 2016. 2: 311-340.
20. Marth C, Landoni F, Mahner S, McCormack M, Gonzalez-Martin A, et al. 'Cervical Cancer: ESMO Clinical Practice Guidelines for Diagnosis, Treatment and Follow-Up'. Annals of Oncology. 2017. 28: 72-83.
21. Agustiansyah, Patiyus, Rizal Sanif, Siti Nurmaini, Irfannuddin, et al. 'WHO Global Strategy in Eradication of Cervical Cancer'. Bioscientia Medicina : Journal of Biomedicine and Translational Research. 2021. 5: 818-824.
22. Canfell, Karen. 'Towards the Global Elimination of Cervical Cancer'. Papillomavirus Research (Amsterdam, Netherlands). 2019. 8: 100170.
23. Singh, Deependra, Jerome Vignat, Valentina Lorenzoni, et al. 'Global Estimates of Incidence and Mortality of Cervical Cancer in 2020: A Baseline Analysis of the WHO Global Cervical Cancer Elimination Initiative'. The Lancet Global Health. 2023. 11: 197-206.
24. Zhou, Dachuang, Di Zhang, Yi Wang, Kejia Zhou, et al. 'Optimizing Strategy for Cervical Cancer Prevention in China: A Comprehensive Modeling Analysis'. Cost Effectiveness and Resource Allocation. 2025. 23: 20.
25. Fuke, Rujuta Parimal, Mangala Sonak, Monika Singh. 'Role of Colposcopy in the Evaluation of Unhealthy Cervix and Cervical Intraepithelial Neoplasia'. Journal of Evidence Based Medicine and Healthcare. 2020. 7: 1506-1511.
26. Arbyn, Marc, Guglielmo Ronco, Ahti Anttila, et al. 'Evidence Regarding Human Papillomavirus Testing in Secondary Prevention of Cervical Cancer'. 2012. 30: 88-99.
27. Jung, Leonard, Gilbert Georg Klamminger, Meletios P. Nigdelis, et al. 'Impact of HPV Testing Based on the 2020 Update of the German Cervical Cancer Screening Program—Data from a Retrospective Monocentric Study'. Cancers. 2025. 17: 2024.
28. Wentzensen, Nicolas, Joan L Walker, Michael A Gold, et al. 'Multiple Biopsies and Detection of Cervical Cancer Precursors at Colposcopy'. Journal of Clinical Oncology, ahead of print, January 1. 2015.
29. Müller K, Soergel P, Hillemanns P, Jentschke M. 'Accuracy of Colposcopically Guided Diagnostic Methods for the Detection of Cervical Intraepithelial Neoplasia'. Geburtshilfe Und Frauenheilkunde. 2016. 76: 182-187.
30. Origoni, Massimo, Francesco Cantatore, Francesco Sopracordevole, et al. 'Colposcopy Accuracy and Diagnostic Performance: A Quality Control and Quality Assurance Survey in Italian Tertiary-Level Teaching and Academic Institutions—The Italian Society of Colposcopy and Cervico-Vaginal Pathology (SICPCV)'. Diagnostics. 2023. 13: 1906.
31. Soutter, William P, Emmanuel Diakomanolis, Deirdre Lyons, et al. 'Dynamic Spectral Imaging: Improving Colposcopy'. Clinical Cancer Research. 2009. 15: 1814-1820.
32. Alfonzo, Emilia, Chenyang Zhang, Forogh Daneshpip, Björn Strander. 'Accuracy of Colposcopy in the Swedish Screening Program'. Acta Obstetricia et Gynecologica Scandinavica. 2023. 102: 549-555.
33. Moss, Esther L, Kalyan K Dhar, Jennifer Byrom, Peter W Jones, et al. Redman. 'The Diagnostic Accuracy of Colposcopy in Previously Treated Cervical Intraepithelial Neoplasia'. Journal of Lower Genital Tract Disease. 2009. 13: 5.
34. Najib, Fatemeh Sadat, Masooumeh Hashemi, Zahra Shiravani, Tahereh Poordast, et al. 'Diagnostic Accuracy of Cervical Pap Smear and Colposcopy in Detecting Premalignant and Malignant Lesions of Cervix'. Indian Journal of Surgical Oncology. 2020. 11: 453-458.
35. Thompson, Valerie, Raymond Marin. 'Is Colposcopy Necessary at Twelve Months after Large Loop Excision of the Transformation Zone? A Clinical Audit'. Australian and New Zealand Journal of Obstetrics and Gynaecology. 2013. 53: 571-573.

36. Bornstein, Jacob, James Bentley, Peter Bösze, et al. '2011 Colposcopic Terminology of the International Federation for Cervical Pathology and Colposcopy'. Obstetrics and Gynecology. 2012. 120: 166-172.
37. Bigrigg A, Haffenden DK, Read MD, Codling BW, Sheehan AL. 'Efficacy and Safety of Large-Loop Excision of the Transformation Zone'. 1994. 343: 32-34.
38. Arbyn, Marc, Charles W E Redman, Freija Verdoodt, et al. 'Incomplete Excision of Cervical Precancer as a Predictor of Treatment Failure: A Systematic Review and Meta-Analysis'. The Lancet Oncology. 2017. 18: 1665-1679.
39. Demarquet, Emilie, Julien Mancini, Lise Preaubert, et al. 'Risk Factors of Post-Large Loop Excision of the Transformation Zone Recurrent High-Grade Cervical Intraepithelial Lesion: A Prospective Cohort Study'. Journal of Lower Genital Tract Disease. 2019. 23: 18-23.
40. Yingyongwatthanawitthaya, Treerin, Watcharin Chirdchim, Chanya Thamrongwuttikul, Panya Sananpanichkul. 'Risk Factors for Incomplete Excision after Loop Electrosurgical Excision Procedure (LEEP) in Abnormal Cervical Cytology'. Asian Pacific Journal of Cancer Prevention: APJCP. 2017. 18: 2569-2572.
41. Butorac, Dražan, Bernarda Škrtić, Iva Pitner, Krunoslav Kuna, et al. 'POSITIVE CONE MARGINS - A DISADVANTAGE OF THE LARGE LOOP EXCISION OF TRANSFORMATION ZONE TECHNIQUE?' Acta Clinica Croatica. 2024. 63: 300-305.
42. Cong, Qing, Yi Yu, Yu Xie, Yanyun Li, et al. 'Risk Factors of LEEP Margin Positivity and Optimal Length of Cervical Conization in Cervical Intraepithelial Neoplasia'. Frontiers in Oncology. 2023. 13: 1209811.
43. Dai, Mengying, Yang Liu, Yan Hu, et al. 'Combining Multiparametric MRI Features-Based Transfer Learning and Clinical Parameters: Application of Machine Learning for the Differentiation of Uterine Sarcomas from Atypical Leiomyomas'. European Radiology. 2022. 32: 7988-7997.
44. Moscicki, Anna-Barbara, Yifei Ma, Charles Wibbelsman, et al. 'Rate of and Risks for Regression of Cervical Intraepithelial Neoplasia 2 in Adolescents and Young Women'. Obstetrics and Gynecology. 2010. 116: 1373-1380.
45. Shanmugasundaram, Srinidhi, Jianxin You. 'Targeting Persistent Human Papillomavirus Infection'. Viruses . 2017. 9: 229.
46. Trimble, Cornelia L, Steven Piantadosi, Patti Gravitt, et al. 'Spontaneous Regression of High-Grade Cervical Dysplasia: Effects of Human Papillomavirus Type and HLA Phenotype'. Clinical Cancer Research. 2005. 11: 4717-4723.
47. Alukal, Anila Tresa, Rema P, Suchetha S, et al. 'Evaluation of Factors Affecting Margin Positivity and Persistent Disease After Leep for Cervical Intraepithelial Neoplasia'. Journal of Obstetrics and Gynaecology of India. 2021. 71: 411-416.
48. Butorac, Dražan, Bernarda Škrtić, Marijo Čukelj, Krunoslav Kuna, et al. 'TWENTY-YEAR EXPERIENCE WITH LARGE LOOP EXCISION OF THE TRANSFORMATION ZONE AT SESTRE MILOSRDNICE UNIVERSITY HOSPITAL CENTRE'. Acta Clinica Croatica. 2019. 58: 463-466.
49. Chen, Yaxia, Hongxian Lu, Xiaoyun Wan, Weiguo Lv, et al. 'Factors Associated with Positive Margins in Patients with Cervical Intraepithelial Neoplasia Grade 3 and Postconization Management'. International Journal of Gynaecology and Obstetrics: The Official Organ of the International Federation of Gynaecology and Obstetrics. 2009. 107: 107-110.
50. Durmuş, Yasin, Alper Karalök, Derman Başaran, et al. 'Can We Predict Surgical Margin Positivity While Performing Cervical Excisional Procedures?' Journal of Obstetrics and Gynaecology: The Journal of the Institute of Obstetrics and Gynaecology. 2020. 40: 666-672.
51. UK Government. Colposcopic Diagnosis, Treatment and Follow up - GOV.UK. July 9. 2025.
52. Zhao, Xue-Lian, Zhi-Hua Liu, Shaung Zhao, et al. 'Efficacy of Point-of-care Thermal Ablation among High-risk Human Papillomavirus Positive Women in China'. International Journal of Cancer. 2021. 148: 1419-1427.
53. Khunnarong, Jakkapan, Nitinan Bunyasontikul, Siriwan Tangjitgamol. 'Treatment Outcomes of Patients With Cervical Intraepithelial Neoplasia or Invasive Carcinoma Who Underwent Loop Electrosurgical Excision Procedure'. World Journal of Oncology. 2021. 12: 111-118.
54. Hallam NF, West J, Harper C, et al. 'Large Loop Excision of the Transformation Zone (LLETZ) as an Alternative to Both Local Ablative and Cone Biopsy Treatment: A Series of 1000 Patients'. Journal of Gynecologic Surgery. 1993. 9: 77-82.
55. Heydari, Fatima, Silvia de Sanjosé, Judith Peñafiel Muñoz, Maria-Eulalia Fernández-Montolí. 'Long-Term Reassurance with Negative High-Risk Human Papillomavirus (HR-HPV) and Clear Margins After Large Loop Excision of the Transformation Zone (LLETZ)'. Cancers. 2025. 17: 487.
56. Dobbs SP, Asmussen T, Nunns D, Hollingworth J, Brown LJ, et al. 'Does Histological Incomplete Excision of Cervical Intraepithelial Neoplasia Following Large Loop Excision of Transformation Zone Increase Recurrence Rates? A Six Year Cytological Follow Up'. BJOG: An International Journal of Obstetrics and Gynaecology. 2000. 107: 1298-1301.
57. Heinonen, Annu, Maija Jakobsson, Mari Kiviharju, et al. 'Role of Colposcopy after Treatment for Cervical Intraepithelial Neoplasia'. Cancers. 2020. 12: 1683.
58. Bifulco, Giuseppe, Nicoletta De Rosa, Giada Lavitola, et al. 'A Prospective Randomized Study on Limits of Colposcopy and Histology: The Skill of Colposcopist and Colposcopy-Guided Biopsy in Diagnosis of Cervical Intraepithelial Lesions'. Infectious Agents and Cancer. 2015. 10: 47.
59. Hammes, Luciano S, Paulo Naud, Eduardo P. Passos, et al. 'Value of the International Federation for Cervical Pathology and Colposcopy (IFCPC) Terminology in Predicting Cervical Disease'. Journal of Lower Genital Tract Disease. 2007. 11: 158-165.
60. Pecourt, Mathilde, Jean Gondry, Arthur Foulon, Ségolène Lanta-Delmas, et al. 'Value of Large Loop Excision of the Transformation Zone (LLETZ) without Histological Proof of High-Grade Cervical Intraepithelial Lesion: Results of a Two-Year Continuous Retrospective Study'. Journal of Gynecology Obstetrics and Human Reproduction. 2020. 49: 101621.
61. Ross, Paula T, Nikki L. 'Limited by Our Limitations'. Perspectives on Medical Education, Bibler Zaidi. 2019. 8: 261-264.

62. Talari, Keerthi, Mohit Goyal. 'Retrospective Studies - Utility and Caveats'. The Journal of the Royal College of Physicians of Edinburgh. 2020. 50: 398-402.
63. Sinha, Ian, Sunil Sinha. 'Single-Center Trials in Neonatology: Issues to Consider'. In Seminars in Fetal and Neonatal Medicine, Elsevier BV. 2015. 20.
64. Baumann, Antoine, Julie Henriques, Zohair Selmani, et al. 'HPV16 Load Is a Potential Biomarker to Predict Risk of High-Grade Cervical Lesions in High-Risk HPV-Infected Women: A Large Longitudinal French Hospital-Based Cohort Study'. Cancers. 2021. 13: 4149.
65. Scherer-Quenzer, Anne Cathrine, Jelena Findeis, Saskia-Laureen Herbert, et al. 'The Value of Endocervical Curettage during Large Loop Excision of the Transformation Zone in Combination with Endocervical Surgical Margin in Predicting Persistent/Recurrent Dysplasia of the Uterine Cervix: A Retrospective Study'. BMC Women's Health. 2024b. 24: 461.
66. Dziadkowiec, Oliwier, Jeffery Durbin, Vignesh Jayaraman Muralidharan, Megan Novak, et al. 'Improving the Quality and Design of Retrospective Clinical Outcome Studies That Utilize Electronic Health Records'. HCA Healthcare Journal of Medicine. 2020. 1: 131-138.
67. Heidkamp, Jan, Mirre Scholte, Camiel Rosman, Srirang Manohar, et al. 'Novel Imaging Techniques for Intraoperative Margin Assessment in Surgical Oncology: A Systematic Review'. International Journal of Cancer. 2021. 149: 635-645.
68. Kleijn, Bertram J de, Gijs TN Heldens, Jasmijn M Herruer, et al. 'Intraoperative Imaging Techniques to Improve Surgical Resection Margins of Oropharyngeal Squamous Cell Cancer: A Comprehensive Review of Current Literature'. Cancers. 2023. 15: 896.
69. Young, Kurtis, Enze Ma, Sameer Kejriwal, Torbjoern Nielsen, et al. 'Intraoperative In Vivo Imaging Modalities in Head and Neck Cancer Surgical Margin Delineation: A Systematic Review'. Cancers. 2022. 14: 3416.
70. Javaeed, Arslaan, Sana Shoukat, Saddaf Hina, Zartasha Hameed, et al. 'Knowledge, Attitude, and Practices Related to Cervical Cancer Among Adult Women in Azad Kashmir: A Hospital-Based Cross-Sectional Study'. Cureus. 2019. 11: 4234.
71. Wang, Wei, Emanuele Arcà, Anushua Sinha, Kristina Hartl, et al. 'Cervical Cancer Screening Guidelines and Screening Practices in 11 Countries: A Systematic Literature Review'. Preventive Medicine Reports. 2022. 28: 101813.
72. Gupta, Ruchika, Sanjay Gupta, Ravi Mehrotra, Pushpa Sodhani. 'Cervical Cancer Screening in Resource-Constrained Countries: Current Status and Future Directions'. Asian Pacific Journal of Cancer Prevention: APJCP. 2017. 18: 1461-1467.
73. Kundrod, Kathryn A, Jose Jeronimo, Beatrice Vetter, et al. 'Toward 70% Cervical Cancer Screening Coverage: Technical Challenges and Opportunities to Increase Access to Human Papillomavirus (HPV) Testing'. PLOS Global Public Health. 2023. 3: 0001982.
74. Olson, Brody, Beth Gribble, Jasmyni Dias, et al. 'Cervical Cancer Screening Programs and Guidelines in Low- and Middle-Income Countries'. International Journal of Gynaecology and Obstetrics: The Official Organ of the International Federation of Gynaecology and Obstetrics. 2016. 134: 239-246.