International Journal of Multiphysics
Volume 18, No. 3, 2024
ISSN: 1750-9548

Role of Misoprostol on Type 3 Transformation Zone of The Cervix During Colposcopic Examination

Amal Abd El Aziz El Said Nouh, Mona Mostafa Ahmed Mohamed, Bassant Magdy Abd El-Sadek, Reham Abdelhamid Elsaid

Department of Obstetrics and Gynecology, Faculty of Medicine, Zagazig University, Egypt

***Corresponding author:** Bassant Magdy Abd El-Sadek

Email: bsbsmagdy66@gmail.com,

Abstract

Background: Complete visualization of the cervical transformation zone (TZ) is essential for accurate colposcopic assessment, as most cervical precancerous lesions arise from this area. Type 3 transformation zone, in which the squamocolumnar junction is not fully visible, represents a common challenge and may increase the risk of missed cervical lesions. Misoprostol, a prostaglandin E1 analogue, has been suggested as a simple method to improve TZ visibility through cervical ripening. This study aimed to assess the efficacy of vaginal misoprostol in improving transformation zone visibility during cervical cancer screening.

Methods: This prospective interventional study was conducted at Zagazig University Hospitals on 23 women aged ≥35 years with Type 3 transformation zone. All participants received a single intravaginal dose of misoprostol (400 µg), and colposcopy was repeated after 4 hours to assess transformation zone conversion. Colposcopic evaluation included inspection after normal saline, application of 5% acetic acid, and Lugol's iodine. Colposcopy-directed biopsies were taken from suspicious lesions and sent for histopathological examination.

Results: The mean age of participants was 49.7±8.6 years (range 35–65), and the mean parity was 3.5±1.6 (range 1–6). Vaginal discharge was the most common presenting complaint (43.4%), followed by contact bleeding (30.4%). Following misoprostol administration, successful conversion of Type 3 TZ to Type 1 or Type 2 was achieved in 19 women (82.6%), while 4 women (17.4%) showed no conversion. Acetowhite lesions were detected in 78.3% of cases. Misoprostol was generally well tolerated; 52.2% of participants reported no side effects, and mild cramping was the most frequent complaint (34.8%). Biopsies were obtained in 19 cases (69.6%), revealing chronic cervicitis in 68.4% and CIN 1 in 31.6%, with no high-grade lesions detected.

Conclusion: A single intravaginal dose of misoprostol (400 µg) appears to be an effective and well-tolerated method for improving transformation zone visibility in women with Type 3 TZ during colposcopy. This approach may enhance colposcopic evaluation and facilitate directed biopsy in cases with suspected cervical pathology.

Keywords: Misoprostol; Transformation zone; Type 3 TZ; Colposcopy; Cervical screening; Cervical intraepithelial neoplasia.

Introduction

Cervical cancer continues to be a major health concern worldwide. It is currently the fourth most common cancer among women, with nearly 660,000 new cases reported in 2022. However, the burden of cervical cancer is not evenly distributed across regions. These differences are largely driven by unequal access to HPV vaccination, screening, and treatment services. Other contributing factors include variations in HIV prevalence, as well as broader social and economic determinants such as poverty and gender-related inequalities **[1]** (Guida et al., 2022).

Colposcopy remains a key diagnostic step in the assessment of women with abnormal cervical screening results. Using a colposcope a binocular magnifying instrument with a strong light source the cervix can be examined in detail to identify abnormal epithelial changes and guide further management. In clinical practice, colposcopy is most commonly requested following a positive screening test, such as abnormal cytology or a positive result on visual inspection with acetic acid (VIA) **[2]** (Grigore et al., 2021).

For colposcopy to be reliable, complete visualization of the cervical transformation zone (TZ) is crucial, since most precancerous lesions and early cervical cancers arise from this area. The transformation zone is defined as the region between the original squamocolumnar junction (SCJ) and the new SCJ that develops over time**[3]**.

Based on standard colposcopic classification, the transformation zone is described as Type 1, Type 2, or Type 3. In Type 1 TZ, the new SCJ lies entirely on the ectocervix and can be fully seen in a 360° view. Type 2 TZ indicates that the SCJ is partly or completely within the endocervical canal, yet still remains fully visible. In Type 3 TZ, part or all of the SCJ is located inside the endocervical canal and cannot be completely visualized during examination**[4]**.

Type 3 TZ represents a common practical limitation during cervical cancer screening and colposcopy, as incomplete visualization of the SCJ may lead to missed lesions. Previous evidence suggests that this type of transformation zone may be associated with a four- to five-fold higher risk of missed cervical cancer compared with cases where the SCJ is fully visible**[5]** (Wu et al., 2017). It has been estimated that around 10–15% of women presenting for screening have a Type 3 transformation zone, which makes improving assessment in this group an important clinical priority**[6]** (Piccoli et al., 2017).

Misoprostol is a synthetic prostaglandin E1 analogue that promotes cervical ripening by softening and dilating the cervix. It is widely used in obstetrics, particularly for induction of labor and for the management of missed or incomplete first-trimester miscarriage**[7]** (Abubeker et al., 2020). Given its effect on the cervix, intravaginal misoprostol has also been studied as a potential method to improve colposcopic assessment by converting Type 3 TZ into a more visible Type 1 or Type 2 TZ. Early findings in the literature have been encouraging**[5]** (Wu et al., 2017). Accordingly, the present study was designed to evaluate the impact of misoprostol on cervical screening accuracy in women with a Type 3 transformation zone.

Methods:

This prospective interventional study was conducted at the Endoscopy Unit of the Department of Obstetrics and Gynecology, in collaboration with the Pathology Department, Zagazig University Hospitals, during the period from (….) to (….). Women aged 35 years and above who attended the outpatient clinic and were candidates for cervical screening due to an abnormal-looking cervix, unexplained lower genital tract bleeding, contact bleeding, or persistent abnormal vaginal discharge were assessed for eligibility. The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Zagazig University (IRB No# ……). Administrative approval was obtained from the hospital administration prior to the start of data collection. The study was conducted in accordance with the ethical standards of the Declaration of Helsinki (1975 and its subsequent amendments). Written informed consent was obtained from all participants after full explanation of the study objectives, procedures,

possible risks, and expected benefits. Confidentiality of participants' data was ensured throughout the study, and all women were informed of their right to withdraw at any stage without any effect on the quality of the provided medical care.

The sample size was determined based on the expected number of women with Type 3 transformation zone attending the outpatient clinic and endoscopy unit, which was approximately 24 patients over a 6-month period. Considering a previously reported conversion rate of 47.8% following misoprostol administration **(Simon et al. [8] 2022),** the required sample size was estimated to be 23 participants. The calculation was performed using the OpenEpi software, assuming a 95% confidence level and 80% statistical power.

Inclusion criteria; women were considered eligible for inclusion if they were aged 35 years or older and presented with an abnormal-looking cervix on clinical examination, such as a hypertrophied cervix, cervical ectopy, cervical polyp, cervical ulceration, or abnormal cervical vascularity. In addition, women presenting with unexplained lower genital tract bleeding, including contact bleeding, were also included. Patients complaining of persistent abnormal vaginal discharge were similarly considered eligible for enrollment.

Exclusion criteria; Participants were excluded if they had missed or delayed menstrual periods to avoid including possible pregnancy. Women with an obvious cervical growth suggestive of malignancy were not enrolled. Cases presenting with abnormal uterine bleeding were also excluded. Furthermore, women with coagulation disorders or those receiving anticoagulant therapy were excluded due to the potential risk of bleeding complications. Patients with a known allergy to misoprostol or a history of cardiovascular disease were not included. Finally, any woman who refused to participate in the study was excluded.

Operational Design

All eligible participants who met the inclusion criteria were subjected to a standardized assessment protocol. A complete history was obtained from each participant, including personal data such as age, occupation, residence, marital status, parity, and any special habits. Details of the present complaint were recorded with emphasis on onset, duration, course, and any aggravating or relieving factors. A detailed past history was also taken, focusing on any previous cervical operations or procedures, as well as any prior history of cervical abnormalities. Family history was reviewed for any relevant inherited or genetic diseases. In addition, menstrual history was obtained, including the last menstrual period, cycle regularity, and current contraceptive method.

Before undergoing colposcopy, all included women were counseled regarding the procedure. Participants were instructed to avoid attending during menstruation, to abstain from sexual intercourse for 48 hours before the examination, and to avoid using any vaginal medications or douching for 48 hours prior to colposcopy.

During the examination, a sterile speculum was inserted to visualize the cervix. Women diagnosed with a Type 3 transformation zone were administered a single intravaginal dose of misoprostol (400 μg). Colposcopic re-examination was then performed after 4 hours to assess any changes in transformation zone visibility.

The cervix was gently cleaned using normal saline, followed by careful inspection for any abnormal lesions and assessment of the vascular pattern. A 5% acetic acid solution was then applied, and the cervix was examined for acetowhite changes, with evaluation of lesion extent, size, vascular features, and intensity of whitening. Lugol's iodine was subsequently applied to identify iodine-negative areas suggestive of abnormal epithelium. Finally, colposcopy-directed biopsy samples were obtained from any suspicious areas and sent for histopathological examination.

Outcome Measures

The primary outcome of the study was the conversion of the transformation zone from Type 3 to Type 1 or Type 2 after intervention.

Secondary outcomes included: improvement in complete visualization of the squamocolumnar junction, detection of abnormal colposcopic findings after conversion, histopathological results of directed biopsies (when indicated), procedure-related adverse effects such as pelvic pain, cramps, vaginal bleeding, or gastrointestinal symptoms.

Biopsy and Histopathological Assessment

Colposcopy-directed biopsies were obtained from any suspicious lesions. Specimens were labeled and sent to the Pathology Department for histopathological examination. Histopathology results were reported as (chronic cervicitis / CIN1 / CIN2 / CIN3 / invasive carcinoma) according to standard pathological criteria.

Statistical Analysis

All collected data were coded, entered, and statistically analyzed using IBM SPSS Statistics for Windows, version 23.0 (SPSS Inc., Chicago, IL, USA). Qualitative variables were presented as frequency (n) and percentage (%), while quantitative variables were expressed as mean ± standard deviation (SD) for normally distributed data or median and interquartile range (IQR) for non-normally distributed data. The range was also reported when appropriate. Comparisons between categorical variables were performed using the Chi-square test, and Fisher's exact test was applied when the expected cell count assumptions were not fulfilled. For comparisons between two independent quantitative groups, the independent samples t-test was used for normally distributed data. For paired quantitative data, the paired t-test was used to assess changes within the same group. All statistical tests were two-tailed, and a p-value ≤ 0.05 was considered statistically significant.

Results:

A total of 23 women were included in the present study. The mean age of the participants was 49.7 ± 8.6 years, ranging from 35 to 65 years. Most women were either in the 41–50 years age group (39.1%) or aged above 50 years (39.1%), while 21.7% were between 35 and 40 years. Regarding marital status, 65.2% of participants were married, whereas 17.4% were divorced and 17.4% were widowed. The mean parity was 3.5 ± 1.6 (range 1–6), with 39.1% having parity between 3 and 4, and 26.1% being grand multiparous (≥5). Concerning occupation, housewives represented 26.1% of the studied group, followed by office workers (21.7%) and teachers (17.4%). A history of previous cervical surgery was reported in 21.7%, and a family history of cancer was present in 8.6% of participants (Table 1)..

Table1: Sociodemographic Characteristics of Study Participants (N=23)

Characteristic	N	%	Mean ± SD / Range
Age (years)			**49.7 ± 8.6 (35-65)**
35-40 years	5	21.7%	
41-50 years	9	39.1%	
>50 years	9	39.1%	
Marital Status			
Married	15	65.2%	
Divorced	4	17.4%	

Widowed	4	17.4%	
Parity			**3.5 ± 1.6 (1-6)**
1-2	8	34.8%	
3-4	9	39.1%	
≥5	6	26.1%	
Occupation			
Housewife	6	26.1%	
Office Worker	5	21.7%	
Teacher	4	17.4%	
Factory Worker	4	17.4%	
Nurse	2	8.7%	
Previous Cervical Surgery	5	21.7%	
Family History of Cancer	2	8.6%	

Clinically, the mean duration of symptoms was 11.3 ± 6.8 months. The most frequent presenting complaint was persistent vaginal discharge (43.4%), followed by contact bleeding (30.4%) and vulvar warts (26.2%). On speculum examination, a hypertrophied cervix was observed in 26.1% of cases, while abnormal vascularity and cervical ectopy were each detected in 21.7% (Table 2).

Table 2: Clinical Data and Indications for Colposcopy (N=23)

Clinical Feature	N	%	Mean ± SD
Duration of symptoms (months)			**11.3 ± 6.8**
Chief Complaint			
Contact Bleeding	7	30.4%	
Vaginal discharge	10	43.4%	
Vulvar Warts	6	26.2%	
Cervical Appearance			
Hypertrophied cervix	6	26.1%	
Abnormal vascularity	5	21.7%	
Cervical ectopy	5	21.7%	

All enrolled participants had a **Type 3 transformation zone at baseline** (100%). Following intravaginal administration of **misoprostol 400 µg**, successful conversion of the transformation zone to a visible Type 1 or Type 2 was achieved in **19 women (82.6%)**, while **4 women (17.4%)** showed no conversion (Figure 3). When comparing converted versus non-converted cases, there were no statistically significant differences between both groups regarding mean age (49.5 ± 9.3 vs 49.8 ± 8.3 years, p=0.431) or mean parity (3.6 ± 1.6 vs 3.4 ± 1.6, p=0.587). In addition, the distribution of multiparity (≥3) and postmenopausal age (>50 years) did not differ significantly between the two groups (p=0.892 and p=0.651, respectively) (Table 3).

Table 3: Comparison of Characteristics Between Converted and Non-Converted Cases

Characteristic	Converted (n=19)	Non-Converted (n=4)	P-value
Mean Age (years) ± SD	49.5 ± 9.3	49.8 ± 8.3	0.431
Mean Parity ± SD	3.6 ± 1.6	3.4 ± 1.6	0.587
Multiparous (≥3), n (%)	7 (63.6%)	8 (66.7%)	0.892
Postmenopausal age (>50 years), n (%)	4 (36.4%)	5 (41.7%)	0.651

Colposcopic assessment of the studied group revealed that **acetowhite lesions** were detected in **78.3%** of cases. Regarding iodine staining, partial iodine uptake was noted in 56.5%, while complete uptake was reported in 43.5%. Concerning vascular patterns, 39.1% showed a normal pattern, whereas punctation, mosaic pattern, and atypical vessels were observed in 26.1%, 21.7%, and 13.0% of cases, respectively (Table 4).

Table 4: Colposcopic Findings in The Studied Group (N=23)

Colposcopic Feature	N	%	Mean ± SD
Baseline Transformation Zone Type			
Type 3	23	100.0%	
Cervical Ectopy Present	5	21.7%	
Acetowhite Lesion Present	16	78.3%	
Iodine Uptake Pattern			
Partial	13	56.5%	
Complete	10	43.5%	
Vascular Pattern			
Normal	9	39.1%	
Punctation	6	26.1%	
Mosaic	5	21.7%	
Atypical vessels	3	13.0%	

In terms of safety, more than half of the participants (52.2%) reported **no side effects** following misoprostol administration. Mild cramping was the most frequently reported adverse effect (34.8%), followed by nausea (8.7%) and dizziness (4.3%). The mean pain score was **1.8 ± 1.5**, with no cases reporting severe pain. Post-administration bleeding was absent in 52.2% of cases, while minimal and mild bleeding occurred in 34.8% and 13.0%, respectively (Table 5).

Table 5: Safety Profile and Side Effects of Vaginal Misoprostol (N=23)

Parameter	N	%	Mean ± SD
Side Effects			
None	12	52.2%	

Mild cramping	8	34.8%	
Nausea	2	8.7%	
Dizziness	1	4.3%	
Pain Score (0-10)			**1.8 ± 1.5**
No pain (0)	9	39.1%	
Mild (1-4)	8	34.8%	
Moderate (5-6)	6	26.1%	
Severe (7-10)		0.0%	
Post-Administration Bleeding			
None	12	52.2%	
Minimal	8	34.8%	
Mild	3	13.0%	

Colposcopy-directed biopsy was performed in **19 cases (69.6%)**. Histopathological examination showed **chronic cervicitis** in the majority of biopsies, while **CIN 1** was detected in the remaining cases (Table 6).

Table 6: Histopathological Findings of the Studied Biopsies

Histological Finding	N	%	95% CI
Total Biopsies Performed	**19**	**69.6%**	
Histological Diagnosis			
Chronic cervicitis	13	25.0%	
CIN 1	6	18.8%	

Discussion:

The included participants aged mostly in the 41-50 years age group (39.1%) and over 50 years (39.1%). These findings align with **Li et al. [9]**, who reported a mean age of 52.9 ± 11.8 years in their Chinese cohort of 764 women evaluating colposcopy performance in women with Type 3 TZ, noting that 77.0% of patients were 45 years or older. The authors demonstrated that Type 3 TZ is significantly more prevalent in perimenopausal and postmenopausal women due to cervical atrophy and regression of the squamocolumnar junction into the endocervical canal with advancing age, with 11.0% having pathologic CIN2+ at diagnosis.

Regarding parity, the present study showed that 65.2% of participants had three or more children. Similarly, **Manga et al. [4]** in their Cameroonian study evaluating misoprostol effects on Type 3 TZ reported that multiparity was a common characteristic among their study population.

The current study demonstrated that the most common chief complaint was vaginal discharge (43.4%), followed by contact bleeding (30.4%) and vulvar warts (26.2%). The mean duration of symptoms was 11.3 ± 6.8 months. Cervical examination revealed hypertrophied cervix in 26.1%, abnormal vascularity in 21.7%, and cervical ectopy in 21.7% of cases. The relatively long symptom duration observed in our study (mean 11.3 months) raises concerns about delays in seeking medical care, which may be attributed to limited awareness and healthcare

accessibility barriers in resource-limited settings. **Perkins et al. [10]** it was emphasized that persistent symptoms warrant thorough colposcopic evaluation regardless of cytology results, particularly in women with Type 3 TZ where adequate visualization is crucial for detecting cervical precancers.

Our result revealed that 82.6% (19/23) of Type 3 TZ cases successfully converted to Type 1 or Type 2 after misoprostol administration, while 17.4% (4/23) remained as Type 3. This high conversion rate is higher than that reported by **Manga et al. [4]**, who documented a 47.8% conversion rate (43 of 90 women) using either 400 mcg or 600 mcg vaginal misoprostol in their Cameroonian cohort. This may be attributed to the number of studied cases in **Manga et al. [4]** which is more than the number of studied cases in the current study.

The authors found that women who received 600 mcg were more likely to have conversion compared to those receiving 400 mcg ($p=0.037$), and they identified 2.3% of significant cervical lesions (CIN2+) that would have been otherwise missed without misoprostol use.

In a comparative perspective, **Modares Gilani et al. [3]** in their Iranian clinical trial of 78 patients with unsatisfactory colposcopy found that misoprostol (400 mcg administered 12 hours prior to colposcopy) achieved 55.6% transformation zone visibility compared to 72% with vaginal estradiol and 26.9% in the control group. It was concluded that intravaginal misoprostol is well tolerated and more feasible in low- and middle-income countries due to availability and shorter treatment schedule compared to oral or intravaginal estradiol.

Pergialiotis et al. [11] conducted a meta-analysis of randomized controlled trials and reported that treatment with misoprostol enhanced transformation zone visibility during colposcopy by 10.2 times compared to placebo, demonstrating the overall effectiveness of this intervention across multiple studies.

Regarding factors affecting successful conversion of type 3 TZ to more accessible types, the current study showed no statistically significant differences between converted and non-converted cases in terms of mean age (49.5 ± 9.3 vs. 49.8 ± 8.3 years, $p=0.431$), mean parity (3.6 ± 1.6 vs. 3.4 ± 1.6, $p=0.587$), multiparity status (63.6% vs. 66.7%, $p=0.892$), or postmenopausal status (36.4% vs. 41.7%, $p=0.651$). These findings suggest that conversion success with misoprostol may not be strongly predicted by demographic factors alone. **Manga et al. [4]** similarly reported that response to intravaginal misoprostol administration was not found to be associated with age, parity, menopausal status, or cervical cytology in their Cameroonian cohort, suggesting that the cervical ripening effects of misoprostol may be relatively consistent across different patient populations. However, the lack of significant associations in our study may be attributed to the relatively small sample size ($n=23$) and limited number of conversion failures ($n=4$), which reduces statistical power to detect meaningful differences. **Modares Gilani et al. [3]** also found no significant differences in baseline characteristics between groups that did or did not achieve satisfactory colposcopy after misoprostol administration, though they noted that postmenopausal women showed lower response rates to misoprostol compared to estradiol therapy.

Regarding colposcopic evaluation of the studied participants, it was revealed that 78.3% of participants had acetowhite lesions upon acetic acid application, while 21.7% had cervical ectopy. Iodine uptake patterns showed partial uptake in 56.5% and complete uptake in 43.5% of cases. Vascular assessment demonstrated normal patterns in 39.1%, punctation in 26.1%, mosaic pattern in 21.7%, and atypical vessels in 13.0% of participants. These colposcopic findings indicate that improved visualization after misoprostol administration enables better assessment of cervical pathology using standard colposcopic criteria established by the International Federation for Cervical Pathology and Colposcopy.

The current study demonstrated an excellent safety profile for vaginal misoprostol, with 52.2% of participants experiencing no side effects, 34.8% reporting mild cramping, 8.7% experiencing nausea, and only 4.3% having dizziness. The mean pain score was 1.8 ± 1.5 on a 0-10 scale **(Downie, [12] 1978)**, with no participants reporting severe pain (scores 7-10). Post-administration bleeding was absent in 52.2%, minimal to mild in 47.8% of

cases. These safety findings demonstrate that the 400 mcg dose used in our protocol is well-tolerated with minimal adverse effects.

Pergialiotis et al. [11] in their meta-analysis of randomized controlled trials found that vaginal misoprostol for overcoming inadequate colposcopies was associated with more side effects such as abdominal cramping and vaginal bleeding compared to placebo, although these were generally mild and well-tolerated. The authors concluded that the benefits of improved visualization outweigh the transient side effects, particularly given the four-to-five-fold increased risk of missed cervical cancers associated with Type 3 TZ.

Regarding histopathological examination of biopsied suspicious areas, the present study showed that biopsies were successfully performed in 19 cases (82.6%) following Type 3 TZ conversion. Histopathological examination revealed chronic cervicitis in 68.4% (13/19) and CIN 1 in 31.6% (6/19) of biopsied cases. No cases of CIN 2, CIN 3, or invasive carcinoma were identified. The absence of high-grade lesions in our cohort may reflect the relatively small sample size or differences in the underlying risk profile of the study population.

The high proportion of chronic cervicitis findings (68.4%) in our study suggests that many women with Type 3 TZ and abnormal cervical appearance have benign inflammatory conditions rather than neoplastic lesions. Nevertheless, the ability to obtain targeted biopsies in 82.6% of cases in our study is a significant clinical advantage, as **Perkins et al. [10]** emphasized in the ASCCP guidelines that inadequate colposcopy (inability to visualize the entire transformation zone) is associated with increased risk of missed disease and requires more aggressive management strategies, including consideration of diagnostic excisional procedures in high-risk populations.

Limitations:

This study has some limitations that should be acknowledged. The small sample size and single-center design limit the generalizability of the findings and reduce statistical power to identify predictors of conversion success. Additionally, the short follow-up period and lack of long-term outcomes prevent assessment of the intervention's impact on detection rates of high-grade lesions or interval cancers.

Conclusion:

This prospective interventional study suggests that a single intravaginal dose of misoprostol (400 μg) administered four hours before colposcopy is an effective and well-tolerated method for improving transformation zone visibility in women with Type 3 TZ. The achieved conversion rate facilitated adequate colposcopic assessment and enabled directed biopsy in most cases. Given its rapid action, acceptable safety profile, and feasibility within a same-day approach, misoprostol may represent a practical option to overcome unsatisfactory colposcopy, particularly in low-resource settings. Further larger multicenter studies are recommended to confirm these findings and to evaluate the impact on detection of high-grade cervical lesions..

References

1. Modares Gilani M, Yarandi F, Zamani N, Nowroozi S, Ramhormozian S, Shirali E. Comparison of estradiol and misoprostol in transformation zone visibility in colposcopy. J Obstet Gynecol Cancer Res 2021;7(2):77–82.

2. Manga SM, Kincaid KD, Boitano TK, Tita AT, Scarinci IC, Huh WK, et al. Misoprostol and estradiol to enhance visualization of the transformation zone during cervical cancer screening: an integrative review. Eur J Obstet Gynecol Reprod Biol 2022;269:16–23.

3. Wu T, Wang Y, Cui X, Xue P, Qiao Y. AI-based identification method for cervical transformation zone within digital colposcopy: development and multicenter validation study. JMIR Cancer 2025;11(1):e69672.

4. Li X, Zhao Y, Xiang F, Dong R, Wang X, Han D, et al. Evaluation of the diagnostic performance of colposcopy in the detection of cervical high-grade squamous intraepithelial lesions among women with transformation zone type 3. BMC Cancer 2024;24(1):381.

5. Perkins RB, Guido RS, Castle PE, Chelmow D, Einstein MH, Garcia F, et al. 2019 ASCCP risk-based management consensus guidelines for abnormal cervical cancer screening tests and cancer precursors. J Low Genit Tract Dis 2020;24(2):102–31.

6. Pergialiotis V, Vlachos DE, Pitsouni E, Perrea D, Vlachos GD. Vaginal misoprostol for overcoming inadequate colposcopies: a meta-analysis of randomized controlled trials. J Low Genit Tract Dis 2015;19(3):257–61.