ORIGINAL RESEARCH

Factors Associated with Lesion Recurrence Following Cervical Conization

Juan Zhao, MD; Xinyu Liu, MM; Jie Gao, MD; Huan Xiao, BM; Yanrong Jin, MM; Yanan Wang, BM; Wei Ma, BM

ABSTRACT

Objective • To investigate the factors influencing lesion recurrence during the follow-up after cervical conization and evaluate the clinical value of human papillomavirus (HPV) testing and thinprep cytology test (TCT) in postoperative follow-up patients undergoing cervical conization.

Methods • A total of 289 patients with cervical lesions who underwent primary cervical conization at our hospital between January 1, 2018, and December 31, 2019, were included in this study. TCT, HPV testing, and colposcopy were performed every 6 months for a follow-up period of 3 years. Based on the follow-up results, the patients were divided into recurrence and non-recurrence groups. The basic and colposcopic data of the two groups were analyzed to identify factors influencing lesion recurrence. Additionally, the clinical value of HPV testing and TCT in postoperative follow-up and recurrence diagnosis of patients undergoing cervical conization was assessed.

Results • The recurrence group showed significantly higher age of onset, concurrent rate of other chronic diseases, and parity, as well as a markedly lower barrier contraceptive rate compared to the non-recurrence group, with statistically significant differences ($P < .05$). In the recurrence group, the type III transformation zone (TZ) predominated (59.26%), which significantly differed from the non-recurrence group ($P < .05$). The detection rates of abnormal TCT findings and HPV infections in postoperative reexaminations were significantly higher in the recurrence group compared to the non-recurrence group ($P < .05$), whereas no significant differences were observed between the two groups before cervical conization ($P > .05$). Among the recurrence group (n = 54), 52 cases (96.3%) had HPV infections, and 29 cases (53.7%) had abnormal TCT findings, with a significantly higher detection rate for HPV infections ($P < .05$). The area under the receiver operating characteristic (ROC) curve (AUC) for HPV testing, TCT, and combined HPV testing with TCT after cervical conization were 0.861, 0.712, and 0.882, respectively. These results indicate that HPV testing alone performs similarly to combined HPV testing with TCT and significantly outperforms TCT alone in predicting lesion recurrence after cervical conization.

Conclusions • Factors influencing lesion recurrence after cervical conization include patient age, barrier contraceptive rate, concurrent rate of other chronic diseases, parity, and type of transformation zone. HPV testing alone is more sensitive and accurate than TCT in predicting lesion recurrence during postoperative follow-up of patients undergoing cervical conization. This finding can reduce missed diagnoses and provide a significant theoretical basis for postoperative follow-up of patients undergoing cervical conization. (*Altern Ther Health Med.* 2023;29(6):50-55).

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INTRODUCTION

Cervical carcinoma is a common malignancy that poses a significant threat to female health. Squamous intraepithelial lesion (SIL) of the cervix, previously known as cervical intraepithelial neoplasia (CIN), represents a group of precancerous lesions that play a crucial role in the development and progression of invasive cervical carcinoma.[1] In 2014, the World Health Organization classified SIL into low-grade SIL (LSIL), corresponding to CIN I, and high-grade SIL (HSIL), encompassing CIN II and CIN III.[1-2] This classification indicates that the progression of cervical

carcinoma is a continuous process. While CIN I can resolve spontaneously in most cases, CIN II and CIN III have the potential to progress to cervical carcinoma, typically requiring an average of 8-12 years.[2]

Timely detection and treatment of HSIL (CIN II-III) are paramount for preventing cervical carcinoma. Cervical conization is an effective approach for diagnosing and treating HSIL (CIN II-III). However, it is important to note that lesion recurrence may occur in patients who have undergone cervical conization.[3] Therefore, it is crucial to investigate the high-risk factors associated with lesion recurrence after cervical conization, as this knowledge can contribute to the prevention of invasive cervical carcinoma. Therefore, this study aimed to investigate the factors influencing lesion recurrence during the follow-up after cervical conization.

MATERIALS AND METHODS

Study Design and Patient Population

A retrospective cohort study was conducted to investigate factors associated with lesion recurrence after cervical conization in HSIL patients. A total of 289 HSIL patients, aged 26-72 years, treated at Luhe Hospital, Tongzhou District, Beijing, China, between January 1, 2018, and December 31, 2019, were included in the study. Lesion recurrence was defined as the presence of cervical intraepithelial neoplasia detected by tissue biopsy at 6 months after cervical conization. Non-recurrence was determined by the absence of CIN lesions observed through tissue biopsy within 3 years following cervical conization.

Inclusion Criteria. (1) HSIL patients who underwent primary cervical conization using loop electrosurgical excision procedure (LEEP) at Luhe Hospital; (2) Patients with clean resection margins after cervical conization; (3) Patients who underwent TCT, HPV testing, and colposcopy every 6 months and were followed up for 3 years; (4) Patients with biopsy-confirmed CIN lesions at 6 months after cervical conization.

Exclusion Criteria. (1) Patients with incomplete clinical data; (2) Patients with unclean resection margins after cervical conization or definitive diagnosis of invasive cancer by biopsy after conization, which required conization or hysterectomy based on their condition; (3) Patients with a history of hysterectomy or pelvic radiotherapy; (4) Patients with a follow-up period of less than 3 years; (5) Patients on long-term use of immunosuppressive agents or with human immunodeficiency virus (HIV) infection

In this study, the recurrence group consisted of patients (n = 54) with CIN lesions detected by tissue biopsy. Patients with simple human papillomavirus (HPV) infection but no CIN lesions based on biopsy were excluded from the recurrence group. The non-recurrence group included patients (n = 235) who did not exhibit recurrent lesions based on follow-up results. The mean age of patients in the recurrence group was (48.4 ± 9.21) years, while in the non-recurrence group, it was (43.68 ± 9.29) years.

Ethical approvals for this study were obtained from the Medical Ethics Committee of our hospital, and all patients provided informed consent.

Cytological Examination and Classification

Samples were collected from the cervical squamocolumnar junction of all patients and processed into slices using the ThinPrep cytology test. The samples were then diagnosed according to the 2001 Bethesda System (TBS) criteria for cervical cytopathology. Under the TBS classification, cervical cells are categorized as follows: (1) Normal cells; (2) Atypical squamous cells of undetermined significance (ASCUS) and atypical glandular cells of undetermined significance (AGUS); (3) Atypical squamous cells cannot exclude high-grade squamous intraepithelial lesion (ASC-H); (4) Low-grade squamous intraepithelial lesion (LSIL); (5) High-grade squamous intraepithelial lesion (HSIL); (6) Squamous cell carcinoma (SCC); (7) Atypical glandular cells (AGCs).

The above classification system was used to identify and categorize the observed cellular abnormalities based on their characteristics.

HPV Test

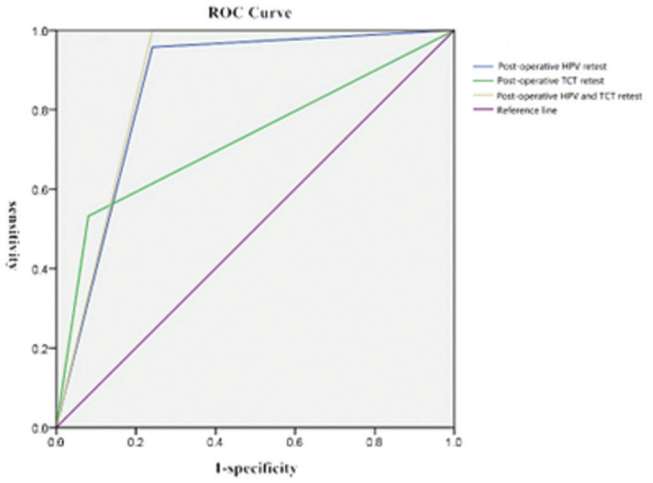
The HPV test conducted in this study utilized the Hybribio HR HPV nucleic acid detection reagent (referred to as the HPV test kit) manufactured in China. This *in vitro* test reagent is based on real-time quantitative PCR designed to detect high-risk (HR) HPV-DNA. The HPV test kit specifically distinguishes HR HPV16 and HPV18 and simultaneously detects 12 other high-risk HPV types, including HPV31, HPV33, HPV35, HPV39, HPV45, HPV51, HPV52, HPV56, HPV58, HPV59, HPV66, and HPV68.

The HPV test kit used in this study was specifically designed to detect high-risk HPV types and employed real-time quantitative PCR as the testing method.

Histopathological Examination Under Colposcopy

Colposcopy was performed on patients who tested positive for HPV-DNA and/or had TCT results of atypical squamous cells of undetermined significance (ASCUS) or higher. Additionally, patients with macroscopic signs of cervical lesions were also included. During colposcopy, suspected cervical lesions were biopsied at multiple points or subjected to endocervical curettage (ECC) by skilled clinicians using a colposcope. The final pathological evaluation was based on the histopathological findings, which served as the gold standard. Two senior pathologists at our hospital were responsible for determining the pathological diagnoses. The identified lesions were classified as normal (inflammation), low-grade squamous intraepithelial lesion (LSIL)/cervical intraepithelial neoplasia 1 (CIN1), high-grade squamous intraepithelial lesion (HSIL)/cervical intraepithelial neoplasia 2 (CIN2), HSIL/CIN3, or cervical carcinoma.

Figure 1. Predictive value of the three test methods for the findings of re-colposcopy in patients undergoing cervical conization.



Cervical Conization

Patients with colposcopic biopsy results suggesting high-grade squamous HSIL/ CIN2 or HSIL/CIN3 underwent cervical conization after informed consent. The cone height and cone width measurements were taken for all samples. Two senior pathologists at our hospital carried out the pathological evaluation. Based on the histopathological findings, the lesions were classified as normal (inflammation), low-grade squamous intraepithelial lesion (LSIL)/cervical intraepithelial neoplasia 1 (CIN1), HSIL/CIN2, HSIL/CIN3, or cervical carcinoma.

Statistical Analysis

The data were analyzed using the Statistical Product and Service Solutions (SPSS) 22.0 software package (IBM, Armonk, NY, USA). Measurement data were expressed as mean ± standard deviation ($\bar{x} \pm s$) and were compared using a one-way analysis of variance or t-test. All statistical analyses were performed using SPSS 22.0 (Chicago, IL). Continuous data parameters were analyzed using the mean ± standard deviation ($\bar{x} \pm s$) for normally distributed data. The median, 25th quartile, and 75th quartile was utilized if the data distribution was skewed. Categorical data were presented as percentages (%). The Kruskal-Wallis test was utilized to obtain the results for univariate analysis of continuous data. The chi-square test was performed for the analysis of categorical data. The statistical significance level was set at $P < .05$.

RESULTS

Correlative Analysis of Basic Data After Cervical Conization

A total of 289 patients who underwent cervical conization were included in this study. All enrolled patients underwent TCT, HPV testing, and colposcopy every 6 months and were closely followed up for 3 years. Based on the follow-up

Table 1. Correlation Analysis of Basic Data of Patients in Two Groups

Group	Recurrence Group (n = 54)	Non-Recurrence Group (n = 235)	χ^2	*P* value
Age				
≤30	7.4% (4/54)	8.9% (21/235)	28.82	.00
31-40	9.26% (5/54)	36.6% (86/235)		
41-50	31.48% (17/54)	30.6% (72/235)		
≥51	51.85% (28/54)	23.8% (56/235)		
Barrier Contraceptive Rate	25.9% (14/54)	41.2% (97/235)	3.96	.04
Concurrent Rate of Other Chronic Diseases	48.1% (26/54)	33.2% (78/235)	9.64	.02
Gravidity	2.54±1.58	2.41±1.21	/	.34
Parity	1.46±0.86	1.02±0.54	/	.01

Table 2. Correlation Analysis of Primary Colposcopic Findings in The Two Groups

Group	Recurrence Group (n = 54)	Non-Recurrence Group (n = 235)	χ^2	*P* value
TCT Classification			1.29	.82
Negative	35.19% (19/54)	31.06% (73/235)		
ASCUS	27.78% (15/54)	28.51% (67/235)		
LSIL	18.52% (10/54)	18.30% (43/235)		
HSIL	9.26% (5/54)	14.04% (33/235)		
ASCUS-H	9.26% (5/54)	8.08% (19/235)		
HPV Type			8.12	.06
HPV negative	3.70% (2/54)	2.13% (5/235)		
HPV16$^+$	18.52% (10/54)	31.06% (73/235)		
HPV18$^+$	3.7% (2/54)	1.70% (4/235)		
HPVHR$^+$	38.89% (21/54)	45.96% (108/235)		
Comprehensive HPV$^+$	35.19% (19/54)	19.15% (45/235)		
TZ Type			13.16	.00
I	16.70% (9/54)	34.04% (80/235)		
II	24.07% (13/54)	33.61% (79/235)		
III	59.26% (32/54)	32.34% (76/235)		
Pathological Finding of Colposcopy			0.61	.74
Normal	3.70% (2/54)	4.26% (10/235)		
LSIL	12.96% (7/54)	11.49% (27/235)		
HSIL	83.33% (45/54)	84.26% (198/235)		
Pathological Finding of ECC			1.92	.41
Negative	85.18% (46/54)	80.85% (190/235)		
LSIL	0.0% (0/54)	3.83% (9/235)		
HSIL	14.81% (8/54)	15.32% (36/235)		

Abbreviations: TCT, ThinPrep cytology test; ASCUS, Atypical Squamous Cells of Undetermined Significance; LSIL, Low-grade Squamous Intraepithelial Lesion; HSIL, High-grade Squamous Intraepithelial Lesion; HPV, Human Papillomavirus; TZ, Transformation Zone; ECC, Endocervical Curettage.

Table 3. Correlation Analysis of Re-Colposcopic Findings in Two Groups After Cervical Conization

Group	Recurrence Group (n = 54)	Non-Recurrence Group (n = 235)	χ^2	*P* value
TCT classification			71.201	.00
Negative	46.30% (25/54)	89.79% (211/235)		
ASCUS	20.37% (11/54)	7.23% (17/235)		
LSIL	20.37% (11/54)	2.13% (5/235)		
HSIL	12.96% (7/54)	0.0% (0/235)		
ASCUS-H	0.0% (0/54)	0.85% (2/235)		
HPV type			98.56	.00
HPV negative	3.70% (2/54)	76.17% (179/235)		
HPV16$^+$	5.56% (3/54)	4.26% (10/235)		
HPV18$^+$	3.70% (2/54)	0.85% (2/235)		
HPVHR$^+$	64.81% (35/54)	12.77% (30/235)		
Comprehensive HPV$^+$	22.22% (12/54)	5.96% (14/235)		
TZ			16.22	.00
I	14.81% (8/54)	28.94% (68/235)		
II	16.67% (9/54)	37.45% (88/235)		
III	68.52% (37/54)	33.62% (79/235)		
Pathological Finding of Colposcopy			259.00	.00
Normal	0% (0/54)	100% (235/235)		
LSIL	46.30% (25/54)	0% (0/235)		
HSIL	53.70% (29/54)	0% (0/235)		
Pathological Finding of ECC			9.42	.00
Negative	94.44% (51/54)	100% (235/235)		
LSIL	5.56% (3/54)	0.0% (0/235)		
HSIL	0.0% (0/54)	0.0% (0/235)		

Abbreviations: TCT, ThinPrep cytology test; ASCUS, Atypical Squamous Cells of Undetermined Significance; LSIL, Low-grade Squamous Intraepithelial Lesion; HSIL: High-grade Squamous Intraepithelial Lesion; HPV, Human Papillomavirus; TZ, Transformation Zone; ECC, Endocervical Curettage.

Table 4. Correlation of TCT and HPV test findings with re-colposcopic findings after cervical conization

		HPV		Total	*P* value
		Positive	Negative		
TCT	Positive	45	7	52	.000
	Negative	62	175	237	
Total		107	182	289	

Note: TCT, ThinPrep cytology test; HPV, Human Papillomavirus.

Table 5. AUC of ROC

	HPV test	TCT	HPV test combined with TCT
AUC	0.861	0.712	0.882

Note: AUC represents the Area Under the Curve in the Receiver Operating Characteristic (ROC) analysis. A higher AUC value indicates a better predictive performance of the corresponding test in predicting lesion recurrence after cervical conization.

results, the patients were categorized into the recurrence group and the non-recurrence group (pathologically normal group). Age stratification showed a statistically significant difference between the two groups ($P<.05$). In the recurrence group, the proportion of patients aged ≥51 years old was significantly higher [51.85% (28/54)] compared to other age groups. In the non-recurrence group, the majority of patients were aged 31-40 years [36.6% (86/235)] and 41-50 years [30.6% (72/235)].

The barrier contraceptive rates were significantly higher in the non-recurrence group than in the recurrence group, with a statistically significant difference between the two groups ($P < .05$). The concurrent rate of other chronic diseases was much higher in the recurrence group than in the non-recurrence group, demonstrating a statistically significant difference ($P < .05$). Gravidity was comparable between the two groups, but the parity in the recurrence group was significantly higher than in the non-recurrence group, showing a statistically significant difference ($P<.05$), refer to Table 1.

Correlation Analysis of Primary Colposcopic Findings After Treatment Of HSIL

Based on the analysis of the recurrence group and non-recurrence group following cervical conization, the TCT and HPV test findings were comparable between the two groups before cervical conization ($P>.05$). No statistically significant differences were observed in the pathological findings of colposcopy and ECC ($P > .05$). However, a significant difference was found in the type of transformation zone (TZ) during colposcopy ($P<.05$). The recurrence group showed a predominant TZ III [approximately 59.26% (32/54)], which was significantly higher than that in the non-recurrence group ($P<.05$), refer to Table 2.

Correlation Analysis of Re-Colposcopic Findings After Treatment of HSIL

The findings of TCT, HPV test, and colposcopy conducted every 6 months in patients after cervical conization revealed that the detection rates of abnormal TCT findings and HPV infections were significantly higher in the recurrence group compared to the non-recurrence group. These differences were statistically significant ($P < .05$). Moreover, the majority of cases in the recurrence group exhibited TZ III as the type of transformation zone, which was significantly higher than that observed in the non-recurrence group. This difference was also statistically significant; refer to Table 3.

TCT and HPV Test Findings in the Recurrence Group after Cervical Conization

In the group of patients who underwent cervical conization, the TCT and HPV-positive rates were 17.99% (52/289) and 37.02% (107/289), respectively, indicating statistically significant differences between the two groups ($P < .05$). Among the patients in the recurrence group (n = 54), 96.3% (52/54) had HPV infections, and 53.7%

(29/54) had abnormal TCT findings. The detection rate of HPV infections was significantly higher than that of abnormal TCT findings, showing a statistically significant difference. Using the pathological findings of re-colposcopy ≥CIN I as the gold standard for recurrence, the area under the receiver operating characteristic (ROC) curve (AUC) was 0.861 for the HPV test, 0.712 for TCT and 0.882 for the combination of TCT and HPV test.

DISCUSSION

HSIL of the cervix plays a crucial role in the development and progression of invasive cervical carcinoma. Cervical conization is an effective method for diagnosing and treating HSIL. Unfortunately, studies have shown that approximately 15% of patients experience lesion recurrence following cervical conization.[4] Currently, the high-risk factors contributing to the persistence or recurrence of HSIL after LEEP can be categorized into three types: social factors, individual immune factors, and local cervical factors. Previous studies investigating the clinical characteristics of lesion recurrence after cervical conization have identified several key factors associated with persistence or recurrence, including HR HPV positivity, positive resection margin following cervical conization, age, immune status, and involvement of multiple quadrants.[5,6] However, there is limited available data on such studies, and the counseling and clinical management of patients with recurrent lesions remain challenging. Therefore, this study aimed to investigate the clinical data, diagnosis, and treatment of HSIL patients with recurrent lesions after cervical conization. The findings of this study aim to provide insights into the management approaches for patients with recurrent lesions.

Age has been identified as a significant risk factor for the recurrence of cervical lesions.[7] A study focusing on postmenopausal women revealed a strong association between menopausal status and persistent residual disease in females. Endocrine levels were found to be a risk factor for persistent cervical lesions in menopausal women, with a risk exceeding 80%.[8] Another retrospective cohort study included 218 patients with positive resection margins after cervical conization. The study followed up on these patients and found that the rates of residual lesions and recurrence were influenced by factors such as patient age, menopausal status, gravidity, parity, and HPV results.[9] This study focused on patients with negative resection margins after cervical conization, excluding those with positive resection margins after primary cervical conization. The findings emphasized the significant role of age in the recurrence of lesions following cervical conization. The results indicated that as age increased, the number of patients with other chronic diseases also increased, colposcopic exposure was unsatisfactory (i.e., TZ III), and there were significantly more cases of recurrent lesions after cervical conization. The risk of lesion recurrence did not show a clear association with gravidity but increased with higher parity and a decrease in barrier contraceptive rate.

Based on these high-risk factors, screening management could be appropriately implemented for patients undergoing cervical conization, taking into account their age and complications, and emphasizing the importance of health education. Specifically, for younger patients, contraceptive education should be prioritized to encourage the use of barrier contraception, thereby further reducing the occurrence of lesion recurrence after cervical conization.

HPV testing, TCT, and colposcopy play crucial roles in the post-cervical conization follow-up.[10-12] However, there is limited research on the impact of TCT and HPV screening on lesion recurrence after cervical conization. For instance, a study conducted on 584 patients to investigate long-term follow-up and risk factors for recurrence after cervical conization found that the recurrence rate was higher in HR-HPV-positive patients compared to HR-HPV-negative patients. Furthermore, patients with abnormal TCT findings had a higher recurrence rate than those with normal TCT findings, with statistically significant differences ($P < .05$) observed. The study also revealed that the combined HR-HPV test and liquid-based TCT had a sensitivity and negative predictive value of 100.00% in predicting recurrence.[13]

The results of this study indicated that there were no statistically significant differences between the recurrence group and the non-recurrence group after cervical conization in terms of the preoperative detection rate of abnormal TCT findings, HPV type, and pathological grade in colposcopy ($P > .05$). In other words, the presence of abnormal TCT findings, specific HPV types, and certain pathological grades in colposcopy prior to the procedure did not appear to be significantly associated with the recurrence or residual of lesions in patients after cervical conization ($P > .05$). After cervical conization, there was a statistically significant difference in the detection rate of abnormal TCT findings during postoperative reexaminations between the two groups ($P < .05$). It is well known that persistent HPV infection is a known causative factor for cervical carcinogenesis.[12-13]

Studies have shown that HSIL patients with normal cytology and negative HR-HPV results on combined screening 6 months after LEEP have a low risk of residual lesions, with only 0.9% experiencing recurrence. However, for those with cytology findings of ASCUS or higher and HR-HPV infections, the risk of residual lesions increases significantly to 9.6%.[14,15]

In this study, a total of 289 patients who underwent cervical conization were included. Following the procedure, HPV testing and TCT were conducted on these patients. The results revealed a remarkably high HPV-positive rate of 96.3% in the recurrence group, which was significantly higher than the rate of 23.83% observed in the non-recurrence group. Among the 54 patients in the recurrence group, 96.3% (52/54) were found to be infected with HPV, while 53.7% (29/54) exhibited abnormal TCT findings. The detection rate of HPV infections was notably higher than that of abnormal TCT findings, and a statistically significant difference was observed ($P < .05$). This disparity may be attributed to

unsatisfactory colposcopic exposure (TZ III).[16] caused by anatomical changes following cervical conization, leading to limited assessment of cytological findings and reduced sensitivity in cytological diagnosis. Consequently, the results further support the superior performance of HPV testing compared to TCT in detecting lesion recurrence during the follow-up of patients who have undergone cervical conization.

Numerous studies have emphasized the significant role of persistent infections of HPV16 and HPV18 in the progression of cervical lesions.[17,18] In our study, the results of the HPV test conducted in the recurrence group revealed that 64.81% of the patients were positive for high-risk HPV, 22.22% had multiple HPV infections, and the positive rates for HPV16 and HPV18 were 5.56% and 3.7%, respectively. These findings underscore the importance of high-risk HPV infections. Moreover, when using pathological findings of colposcopy ≥CIN I as the benchmark for recurrence, the AUC values for HPV testing, TCT, and combined HPV testing with TCT after cervical conization were 0.861, 0.712 and 0.882, respectively. This finding indicates that in patients undergoing cervical conization, HPV testing alone performs similarly to combined HPV and TCT screening and significantly better than TCT alone in predicting the recurrence of lesions.

Therefore, it is crucial to recognize the significance of HPV testing in the follow-up management after cervical conization. HPV testing alone is both effective and cost-efficient. In cases of recurrent lesions after cervical conization, it is essential to develop individualized management plans considering factors such as age, fertility status, pathological findings, and follow-up conditions. These findings will contribute to the implementation of improved management strategies and the establishment of a solid theoretical foundation.

Study Limitations

It is important to acknowledge the limitations of this study. Firstly, the study sample size was relatively small, which may limit the generalizability of the findings to a larger population. Additionally, the study was conducted at a single center, which could introduce biases and limit the variability of the results. Moreover, the study relied on retrospective data analysis, which is subject to inherent limitations such as incomplete or missing data. Furthermore, the follow-up period in the study was limited to 3 years, which may not capture longer-term outcomes and recurrence rates. Lastly, the study primarily focused on the correlation between HPV testing, TCT, and lesion recurrence, without considering other potential factors that could contribute to recurrence. Future research should address these limitations to provide a more comprehensive understanding of managing recurrent lesions after cervical conization.

CONCLUSION

The findings of this study indicate that patient age, barrier contraceptive rate, concurrent rate of other chronic diseases, parity, and transformation zone (TZ) type are associated with the recurrence of lesions after cervical conization. On the other hand, the type of primary HPV infection, the detection rate of abnormal TCT findings, and pathological grade in colposcopy do not show a significant correlation with lesion recurrence. Importantly, the HPV test alone demonstrates higher sensitivity and accuracy compared to TCT alone in predicting lesion recurrence during the postoperative follow-up of patients who have undergone cervical conization. It highlights the potential of HPV testing as a valuable tool in reducing missed diagnoses and providing a solid foundation for the postoperative management of patients following cervical conization.

CONFLICT OF INTEREST

The authors have no potential conflicts of interest to report relevant to this article.

AUTHORS' CONTRIBUTION

JZ and WM designed the study and performed the experiments; XL and JG collected the data; HX, YJ, and YW analyzed the data; JZ and WM prepared the manuscript. All authors read and approved the final manuscript.

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REFERENCES

1. World Health Organization. *Comprehensive Cervical Cancer Control: A guide to essential practice*. 2nd ed. World Health Organization; 2014:235. [M]
2. Lu Z, Chen J. [Introduction of WHO classification of tumours of female reproductive organs, fourth edition]. *Zhonghua Bing Li Xue Za Zhi*. 2014;43(10):649-650.
3. Baloglu A, Uysal D, Bezircioglu I, Bicer M, Inci A. Residual and recurrent disease rates following LEEP treatment in high-grade cervical intraepithelial lesions. *Arch Gynecol Obstet*. 2010;282(1):69-73. doi:10.1007/s00404-009-1298-3
4. Kocken M, Helmerhorst TJ, Berkhof J, et al. Risk of recurrent high-grade cervical intraepithelial neoplasia after successful treatment: a long-term multi-cohort study. *Lancet Oncol*. 2011;12(5):441-450. doi:10.1016/S1470-2045(11)70078-X
5. Zhang W, Gong X, Wu Q, et al. The Clearance of High-Risk Human Papillomavirus is Sooner After Thin Loop Electrosurgical Excision Procedure (t-LEEP). *J Invest Surg*. 2019;32(6):560-565. doi:10.1080/08941939.2018.1483449
6. Liu L, Chen LM, Tao X, et al. [Clinical outcome and high risk factor for residual lesion analysis of HSIL half a year after loop electrosurgical excision procedure: a clinical study of 1 502 cases]. *ZhonghuaFuChanKeZaZhi*.2017;52(11):751-756.doi:10.3760/cma.j.issn.0529-567X.2017.11.007
7. Murakami I, Ohno A, Ikeda M, et al. Analysis of pathological and clinical characteristics of cervical conization according to age group in Japan. *Heliyon*. 2020;6(10):e05193. doi:10.1016/j.heliyon.2020.e05193
8. Bilibio JP, Monego HI, Binda MLA, Dos Reis R. Menopausal status is associated with a high risk for residual disease after cervical conization with positive margins. *PLoS One*. 2019;14(6):e0217562. doi:10.1371/journal.pone.0217562
9. Chen JY, Wang ZL, Wang ZY, Yang XS. The risk factors of residual lesions and recurrence of the high-grade cervical intraepithelial lesions (HSIL) patients with positive-margin after conization. *Medicine (Baltimore)*. 2018;97(41):e12792. doi:10.1097/MD.0000000000012792
10. Ruan Y, Liu M, Guo J, Zhao J, Niu S, Li F. Evaluation of the accuracy of colposcopy in detecting high-grade squamous intraepithelial lesion and cervical cancer. *Arch Gynecol Obstet*. 2020;302(6):1529-1538. doi:10.1007/s00404-020-05740-x
11. Sun XF, Gu YQ, Wang AC, Wang J, Xie JL. [Value assessment of high-risk HPV test and TCT in the screening of cervical carcinoma]. *Zhonghua Shi Yan He Lin Chuang Bing Du Xue Za Zhi*. 2013;27(4):273-276.
12. Reich O, Regauer S, Kashofer K. Possibly carcinogenic HPV subtypes are a cause of HSIL and negative clinical HPV tests - A European prospective single center study. *Gynecol Oncol*. 2020;158(1):112-116. doi:10.1016/j.ygyno.2020.04.685
13. D'Alessandro P, Arduino B, Borgo M, et al. Loop Electrosurgical Excision Procedure versus Cryotherapy in the Treatment of Cervical Intraepithelial Neoplasia: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Gynecol Minim Invasive Ther*. 2018;7(4):145-151. doi:10.4103/GMIT.GMIT_56_18
14. Tanaka Y, Ueda Y, Kakuda M, et al. Predictors for recurrent/persistent high-grade intraepithelial lesions and cervical stenosis after therapeutic conization: a retrospective analysis of 522 cases. *Int J Clin Oncol*. 2017;22(5):921-926. doi:10.1007/s10147-017-1124-z
15. Chen L, Liu L, Tao X, Guo L, Zhang H, Sui L. Risk Factor Analysis of Persistent High-Grade Squamous Intraepithelial Lesion After Loop Electrosurgical Excision Procedure Conization. *J Low Genit Tract Dis*. 2019;23(1):24-27. doi:10.1097/LGT.0000000000000444
16. Simões RB, Campaner AB. Post-cervical conization outcomes in patients with high-grade intraepithelial lesions. *APMIS*. 2013;121(12):1153-1161. doi:10.1111/apm.12064
17. Bruno MT, Cassaro N, Garofalo S, Boemi S. HPV16 persistent infection and recurrent disease after LEEP. *Virol J*. 2019;16(1):148. doi:10.1186/s12985-019-1252-3
18. Venturoli S, Ambretti S, Cricca M, et al. Correlation of high-risk human papillomavirus genotypes persistence and risk of residual or recurrent cervical disease after surgical treatment. *J Med Virol*. 2008;80(8):1434-1440. doi:10.1002/jmv.21198