

Original Article



Determination of Anti-HPV Diagnostic Value in Genital Warts Compared to Polymerase Chain Reaction (PCR) among Women with Genital Lesions

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Article info

Article History:

Received: November 14, 2025

Revised: August 17, 2026

Accepted: September 2, 2026

ePublished: October 18, 2026

Keywords:

Human papilloma virus,
Polymerase chain reaction, Wart,
Sexually transmitted diseases

Abstract

Introduction: Warts are common skin lesions worldwide, particularly in children and adolescents, with a prevalence of 5–30%. They can, however, affect all age groups. This study aimed to evaluate the prevalence of human papillomavirus (HPV) and assess the diagnostic value of serological anti-HPV testing compared with polymerase chain reaction (PCR) in women with genital lesions.

Methods: In this cross-sectional diagnostic evaluation, 50 women with genital lesions were enrolled, including 25 participants who tested positive and 25 who tested negative for HPV types 16 and 18 by PCR. Demographic and clinical data were collected, including age, smoking status, age at first sexual intercourse, number of sexual partners, number and location of warts, underlying diseases, marital status, lesion site (intra- or extragenital), history of sexually transmitted diseases (STDs), and oral contraceptive use. Findings were compared between groups.

Results: Warts were more frequently located outside the uterus than inside. Anti-HPV testing was positive in 70% of participants, including 84% of PCR-positive participants and 56% of PCR-negative participants. The test demonstrated a sensitivity of 84%, specificity of 44%, positive predictive value of 60%, and negative predictive value of 73.3%. Early age at first sexual intercourse and no prior history of STDs were identified as risk factors for HPV infection.

Conclusion: In this study, based on PCR, anti-HPV serology was more sensitive than specific. However, estimates of diagnostic performance, in particular PPV and NPV, may not be generalizable due to the small sample size.

Introduction

Genital wart (condyloma acuminata), caused by Human Papillomavirus (HPV), is a common sexually transmitted disease, which is important due to its role in increasing the risk of cervical cancer (the fourth cause of cancer morbidity and mortality in women worldwide).^{1,2} Among more than 100 HPV genotypes identified as of now, 15 of them are considered as high-risk genotypes (including HPV-16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 68, 73 and 82) and HPV types 6, 11, 40, 42, 43, 44, 54, 61, 70, 72, 81, 89 are considered as low-risk genotypes.³⁻⁵ Perpetual infection with high-risk types, predominantly HPV-16 and 18, is involved in the majority of cervical cancer cases.^{6,7} Studies show that almost 90% of genital warts are caused by HPV-6 and HPV-11 infections.⁸⁻¹¹ Although genital warts are not typically associated with substantial morbidity or mortality, their existence can lead to psychological distress and impose a significant financial burden on the healthcare system and patient.¹²⁻¹⁴ Genital warts seem to be

more prevalent in females, compared to males¹⁵ and the highest rates of warts tend to occur among 15- to 24-year-old of females.¹⁶ Because the replication cycle of human papillomaviruses is completed only in fully differentiated epithelial cells, isolating the virus from clinical samples is difficult. HPV growth in cell culture is also challenging and limited to specific keratinocyte cells under controlled conditions. This virus can evade the immune system and spread without cell lysis, which reduces inflammatory responses and complicates serological detection due to cross-reactivity. Traditional methods such as the Pap smear have been used to detect cervical cell changes caused by HPV, but issues like false negatives from sampling and microscopic errors limit their diagnostic value. Today, these tests are mainly used for initial screening, while nucleic acid-based molecular techniques have become the preferred tools for accurate HPV detection.^{17,18} There are three main tools for genotyping and diagnostic tests of HPV including: 1- genomic detection techniques

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(Polymerase Chain Reaction (PCR), Real-Time PCR, PCR-RFLP), 2- Hybridization based diagnostic methods (Dot Blot Hybridization, In Situ Hybridization, Southern Blot) and 3- signal amplification (HPV Cervista and Hybrid capture). Although all the aforementioned methods have both drawbacks and benefits, advanced molecular approaches demonstrate superior sensitivity and specificity in detection and genotyping of HPV.¹⁹⁻²¹

Therefore, the present study aimed to determine the diagnostic value of anti-HPV testing in genital warts compared with PCR among women with genital lesions. By evaluating the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the anti-HPV assay, this study seeks to provide evidence for its potential role as an alternative or adjunct diagnostic tool in clinical and public health settings.

Method

Study Design, Setting, and Participants

This is a cross-sectional diagnostic accuracy study conducted at Imam Reza Hospital-related Clinics, Tabriz University of Medical Sciences, between January and November 2021. Women ≥ 18 years old presenting with genital lesions clinically consistent with genital warts or other suspected HPV-related lesions who had sexual activity were included in this study. Written informed consent was obtained from all participants. Patients with prior HPV vaccination, recent antiviral or immunomodulatory therapy (within the past 3 months), known immunodeficiency, Intravenous (IV) drug use history and inability/unwillingness to consent were excluded from our study. Considering the prevalence of HPV and using the Power and Sample Size tool, Sample size was calculated based on expected sensitivity and specificity of the serological test, with type I error ($\alpha = 0.05$) and power = 80%. Finally, 25 patients were determined to be enrolled in each group and the sample size was considered 50. This cross-sectional study included 25 patients with genital lesions clinically diagnosed as genital warts and confirmed positive for HPV subtypes 16 and 18 by PCR, assigned to the case group, and 25 patients with genital lesions but negative PCR results for HPV subtypes 16 and 18 enrolled as the control group. The PCR assay used in the present study was only for HPV types 16 and 18. So, in the current study, PCR negative means no detectable HPV-16/18 but does not rule out infection with other HPV genotypes. For the purpose of the diagnostic evaluation, participants were divided into 25 PCR-positive and 25 PCR-negative participants according to their PCR results. The equal number of participants in the two reference-standard categories is a function of the study sampling approach and should not be interpreted as representative of the prevalence of HPV-16/18 in the target population.

Data Collection

The demographic data of the patients including age, marital status, sexual behavior (number of partners,

time since first sexual intercourse), STI history and contraceptive use were obtained via a questionnaire. Also, the clinical data such as the number and the site of the lesions, were collected by a medical expert. The venous blood samples (10 mL) were taken from patients, and processed separate serum. Samples were kept at -20°C until anti-HPV antibody testing. Serological testing was done using the ELISA method to detect antibodies against specific HPV proteins. The assay detects past exposure, current infection, or both in patients with genital warts. Also, the characteristics of the patients were collected via a questionnaire.

Outcome Measures

In order to compare the anti-HPV diagnostic value with PCR, the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the serology method were evaluated and compared to PCR as the gold standard.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics (Version 26). Descriptive statistics were used to summarize the data, with results presented as mean $\pm$ standard deviation or median [interquartile range] based on the normality of distributions assessed by the Shapiro-Wilk test. Between-group comparisons were performed using independent-samples t-tests or the Mann-Whitney U test based on the normality of numeric distributions and Fisher's Exact Test, or chi-square for categorical variables. Paired-sample t-test, Wilcoxon signed-rank test or McNemar's test were used to evaluate the changes within groups. The diagnostic performance of the Anti-HPV was assessed by evaluating sensitivity, specificity, Positive Predictive Value (PPV), and Negative Predictive Value (NPV). The percentage of PCR-positive participants does not represent the true prevalence of HPV-16/18 in the target population because the number of PCR-positive and PCR-negative participants in the study was equal. PPV, NPV and overall accuracy were therefore interpreted in the light of the study sample. To assess the relation between the risk factors and HPV infection, Binary logistic regression analysis was done. A *P* value of less than 0.05 was considered statistically significant, and 95% confidence intervals were observed for all tests.

Ethical Consideration

This study was approved by the Ethics Committee of Tabriz University of Medical Sciences. Patients' information was kept confidential during the study. Patients did not incur any costs, other than their previous diagnostic evaluations. Written informed consent was obtained from each patient and they were allowed to exit the study at any time.

Results

A total of 50 participants were included in our study in two groups of 25 patients with genital lesions, clinically

diagnosed as genital warts and confirmed positive for HPV infection with PCR, assigned as the case group and 25 patients with genital lesions but negative HPV PCR results recruited as the control group. Table 1 shows the characteristics of the patients. According to the results, number of patients with a history of STD was statistically higher in PCR negative compared to PCR positive group (P value=0.001). Conversely, there was a difference in number of patients in terms of STD history in partner between groups and patients with a positive history of STD were statically more in case group, compared with the control group (P value=0.001). As the aim of our study, in terms of anti-HPV test results, in line with the number of patients with negative test in control group, the number of patients with positive test in the case group was statistically higher (P value=0.031).

Table 2 shows the diagnostic performance of the anti-HPV test. In this study, the diagnostic performance of the anti-HPV test was evaluated in comparison with the polymerase chain reaction (PCR), as the gold standard for diagnosis, among women presenting with genital lesions. The anti-HPV test demonstrated a sensitivity of 84%,

specificity of 44%, positive predictive value (PPV)

of 60%, negative predictive value (NPV) of 73.3%, and an overall accuracy of 64%. The present sample showed a higher sensitivity than specificity for the anti-HPV assay. However, the relatively low specificity indicates a high number of false positive results and the wide confidence intervals indicate limited precision of the estimates. However, its low specificity reflects a considerable rate of false-positive results, meaning that some non-infected individuals may also have a positive result in test. The moderate PPV and NPV values imply that while a negative result is fairly reliable, a positive result should be interpreted with caution.

In order to explore the independent effects of variables, a logistic regression was performed (Table 3). The logistic regression analysis investigated different factors that might be linked to HPV infection among women with genital lesions. A clear and statistically significant association was found with a history of sexually transmitted diseases (STDs) (P value = 0.016). Interestingly, women who had no previous STD history were about 17 times more likely to test positive for HPV compared with those who had

Table 1. characteristics of the patients

	PCR positive (n=25)	PCR negative (n=25)	P value
Age	24.92 ± 4.94	25.48 ± 5.20	0.698
Age at first sexual intercourse	20.44 ± 4.93	19.12 ± 2.40	0.196
Smoking	7 (28%)	4 (16%)	0.248
Number of sexual partners			0.743
1	12 (48%)	13 (52%)	
2	9 (36%)	8 (32%)	
3	3 (12%)	4 (16%)	
4	1 (4%)	0 (0%)	
Lesion site			0.713
Intra vaginal	5 (20%)	4 (16%)	
Extra vaginal	20 (80%)	21 (84%)	
Number of lesions			0.765
1	13 (52%)	12 (48%)	
2	6 (24%)	6 (24%)	
3	5 (20%)	4 (16%)	
4	1 (4%)	3 (12%)	
Past Medical History			0.513
DM	1 (4%)	0 (0%)	
HTN	1 (4%)	2 (8%)	
Marital status			0.269
Single	9 (36%)	6 (24%)	
Married	16 (64%)	19 (76%)	
STD history	4 (16%)	16 (64%)	0.001*
OCP usage history	7 (28%)	7 (28%)	0.623
STD history in partner	19 (76%)	6 (24%)	0.001*
Anti-HPV result			0.031*
Negative	4 (16%)	11 (44%)	
Positive	21 (84%)	14 (56%)	

STD: Sexual Transmitted Disease, HPV: human Papillomavirus, OCP: Oral Contraceptive pills

experienced an STD before (OR = 17.209; 95% CI: 9.476–31.252).

Another significant factor was the age at first sexual intercourse ($P=0.023$). Women who reported an earlier onset of sexual activity were more likely to have HPV infection than those who became sexually active at an older age (OR = 1.242; 95% CI: 0.071–1.822).

In contrast, other variables such as age, smoking, marital status, oral contraceptive use, and number of sexual partners were not significantly related to HPV infection ($P>0.05$). Although being single and older age were associated with slightly higher odds of infection, these differences were not statistically meaningful.

Discussion

HPV infections are the most prevalent sexually transmitted diseases and are commonly subclinical infections. Condyloma acuminata lesions are usually multiple lesions that appear as exophytic papillomatous growths with a brownish or flesh-like appearance. These warts are commonly caused by HPV types 6 and 11, which are responsible for the development of anogenital warts.^{22,23}

In this study, we evaluated the diagnostic value of the serological anti-HPV test compared with PCR as the gold standard among women presenting with genital lesions. 50 women with the diagnosis of genital warts were included in our study. Patients were studied during the positive period of the HPV PCR test. According to previous studies, it has been proven that the serum immunoglobulin levels remain constant during the infection course.²⁴ If a patient is not immunosuppressed, an increase in the level of anti-viral antibodies indicates the establishment of exposure to antigen and the host's immune response. Hence, an increased level of virus-specific antibodies represents the acute or chronic phase of the infection and can be a useful method in identifying infected individuals.²⁵ Our findings showed that the

anti-HPV test has relatively high sensitivity (84%) and a satisfactory negative predictive value (73.3%), suggesting that this assay can effectively detect true HPV-positive cases and may be useful in ruling out infection in non-infected cases. However, the specificity of the test was modest (44%), indicating a considerable proportion of false-positive results. This pattern implies that while the anti-HPV test could serve as a valuable screening tool, its results should be interpreted cautiously and ideally confirmed with molecular testing methods such as PCR. The PPV, NPV and overall accuracy reported in this study should be interpreted in the light of the study sample in which the proportion of PCR-positive and PCR-negative participants was intentionally balanced. Thus, these prevalence-dependent measures may vary substantially in clinical populations with different underlying HPV-16/18 prevalence and should not be directly extrapolated to routine clinical practice.

Our findings are consistent with previous studies that reported variable but generally moderate diagnostic performance of serological assays for HPV. Greer et al. and Brown et al. similarly reported the presence of serological responses to HPV antigens among patients with genital warts, yet they emphasized the limited specificity due to antibody cross-reactivity and the inability of serology to distinguish between past and current infections.^{10,26} The relatively high sensitivity in our study supports the notion that anti-HPV antibodies are often detectable in individuals with active infection, particularly those infected with high-risk genotypes such as HPV-16 and HPV-18. Nevertheless, the reduced specificity highlights the persistent challenge of serological overlap between previous exposure and active disease.

Interestingly, our regression analysis revealed that the absence of a prior history of STDs was significantly associated with HPV infection, which might appear counterintuitive. This could be explained by the possibility that women with a history of STDs have had more frequent screening or treatment, reducing their risk of undiagnosed HPV infection. Another possible explanation is related to behavioural or immunological factors that were not controlled for in this study. Additionally, an earlier age at first sexual intercourse was also identified as a significant risk factor for HPV infection, aligning with numerous epidemiological studies such as Hajibagheri et al.²⁷ that associate early sexual debut with increased

Table 2. the diagnostic value of Anti-HPV compared to HPV-PCR

Variable	Percent	95% Confidence Interval (CI)
sensitivity	84%	63.92-95.46
specificity	44%	24.40-65.07
positive predictive value (PPV)	60%	50.45-68.84
negative predictive value (NPV)	73.33%	50.26-88.21
accuracy	64%	49.19-77.08

Table 3. Risk factors of HPV infection

Variable	Coefficient	P value	Odds ratio (95% CI)
Age	0.800	0.155	2.225 (0.739-6.698)
Age at first sexual intercourse	-1.418	0.023	1.242 (0.071-1.822)
Smoking	-0.795	0.747	0.452 (0.004-5.030)
Marital status (single)	3.389	0.296	29.648 (0.052-40.970)
History of STD (negative)	12.056	0.016	17.209 (9.476-31.252)
OCP usage history	-1.992	0.435	0.435 (0.001-20.344)
Number of sexual partners (n = 1)	0.217	0.108	1.110 (0.101-2.210)

lifetime exposure to HPV and higher risk of infection persistence. In a study done by Tran et al. in Vietnam in 2015, in order to evaluate the possible risk factors for HPV infection, 1550 patients were enrolled. According to their findings, the main risk factors included smoking and older age at the first sexual intercourse.²⁸ These results were in contrast with our results which implied a younger age at the first sexual intercourse as a risk factor for HPV infection which may be due to the use of contraception and wider information among patients of older age.

Other examined variables, including age, marital status, smoking, oral contraceptive use, and number of sexual partners, did not show a statistically significant relationship with HPV infection in our sample. These findings may reflect the small sample size, or the relatively homogeneous nature of our study population, which limited statistical power to detect smaller effects.

From a clinical standpoint, our results suggest that serological testing for anti-HPV antibodies could be a useful adjunctive diagnostic method, especially in resource-limited settings where molecular assays are not readily available. The acceptable sensitivity and high negative predictive value indicate that a negative serological result may reliably exclude HPV infection, thus reducing unnecessary molecular testing. However, due to its lower specificity, the anti-HPV test alone should not be used for definitive diagnosis, but rather as part of a multi-step screening strategy.

This study has several limitations. First, the sample size was relatively small (50 participants) and thus, confidence intervals were wide and the precision and generalizability of the findings were limited. This was a cross-sectional diagnostic assessment, and the equal numbers of PCR-positive and PCR-negative participants means the prevalence observed is not reflective of the underlying prevalence of HPV-16/18 in the target population. Therefore, caution is needed when interpreting PPV, NPV and overall accuracy, which cannot be generalized directly to populations with different prevalence of HPV.

Second, the reference standard was restricted to PCR detection of HPV-16 and HPV-18. Perhaps participants infected with other HPV genotypes, especially HPV-6 and HPV-11, may have been misclassified as PCR-negative. Third, the single-center setting and the enrolment of women with genital lesions may limit the generalizability of the results. Finally, the multivariable logistic regression model may have been unstable and potentially overfitted due to the small sample size, and therefore the observed associations should be interpreted as exploratory. Larger multi-center studies with representative populations and more extensive HPV genotyping are needed.

Conclusion

In this cross-sectional diagnostic evaluation, anti-HPV serology had a sensitivity of 84% and a specificity of 44% compared to PCR detection of HPV-16/18. However, these results should be interpreted with caution because of the small sample size, wide confidence intervals, and the

balance of PCR-positive and PCR-negative participants. Our findings need to be validated in larger studies and representative clinical populations.

Acknowledgments

The authors would like to express their gratitude to the Clinical Research Development Unit of Imam Reza General Hospital in Tabriz, Iran, for their valuable support in conducting this research. Additionally, an AI language model (ChatGPT) was utilized to assist with language refinement and enhance the clarity of the manuscript.

Authors' Contribution

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Competing Interests

Authors declare that there is not any conflict of interest.

Consent to Participate

All participants provided informed consent to participate in this study. Participation was voluntary, and all individuals were informed about the purpose of the research, their role, and their right to withdraw at any time without penalty.

Ethical Approval

This study was approved by the Regional Committee of Research Ethics at Tabriz University of Medical Sciences. Written informed consent was obtained from all participants or their legally authorized representatives prior to enrollment. All procedures were conducted in accordance with the Declaration of Helsinki.

Funding

No funding was received for this manuscript.

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