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Original Research

Association of Cervical Polyps in Early Pregnancy With Late Miscarriage and Spontaneous Preterm Birth: A Retrospective Study

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Abstract

Background: Cervical polyps are often associated with localized inflammatory foci, which may be detected during pregnancy. In symptomatic cases, polypectomy currently represents the primary therapeutic intervention. However, the impact of cervical polyps on pregnancy outcomes and the clinical significance of cervical polypectomy remain subjects of ongoing debate. This study aimed to investigate the relationship between cervical polyps and pregnancy outcomes, focusing on spontaneous preterm birth (SPTB) and late miscarriage, and to evaluate the association of polypectomy with these outcomes. This retrospective study was conducted at a tertiary university-affiliated women's hospital. **Methods**: The study included 9990 consecutive women who underwent vaginal delivery, with or without cervical polyps, over a 12-month period from January to December 2021. All patients had undergone gynecological examination and transvaginal ultrasonography during early pregnancy. The diagnosis of cervical polyps in early pregnancy (4–12 gestational weeks) was determined through gross clinical inspection and confirmed by transvaginal ultrasound. Polypectomy should be considered in cases of heavy vaginal bleeding, secondary infection, excessively long polyps or prolapse of the vaginal orifice, and when cervical malignancy is strongly suspected. The associations of cervical polyps or polypectomy with late miscarriage and SPTB were evaluated using comparative analysis, as well as univariate and multivariate logistic regression. **Results**: A comparative analysis of pregnancy outcomes was performed between two groups: 94 (0.94%) cases with cervical polyps detected in the first trimester and 9896 cases without cervical polyps. The incidence of late miscarriage and SPTB was significantly higher in the polyp group than in the non-polyp group. Multivariate analysis revealed that cervical polyps in first trimester pregnancy was a significant independent risk factor for both late miscarriage (odds ratio [OR]: 96.94, 95% CI: 34.88–269.49, $p < 0.001$) and SPTB before 28 (OR: 31.48, 95% CI: 11.48–86.32, $p < 0.001$), 34 (OR: 26.13, 95% CI: 11.58–58.94, $p < 0.001$), or 37 (OR: 5.13, 95% CI: 2.59–10.17, $p < 0.001$) weeks of gestation. Our analysis demonstrated comparable pregnancy outcomes between the polypectomy and non-polypectomy groups, with no statistically significant association observed between cervical polypectomy and pregnancy outcomes in this cohort. Vaginal bleeding was identified as an independent protective factor for SPTB before 34 weeks of pregnancy in these patients (OR: 0.27, 95% CI: 0.09–0.83, $p = 0.023$). **Conclusions**: Cervical polyps detected during the first trimester were associated with a significantly increased risk of both late miscarriage and SPTB; however, polypectomy did not significantly improve in pregnancy outcomes.

Keywords: cervical polyps; late miscarriage; polypectomy; spontaneous preterm birth

1. Introduction

Cervical polyps, with an incidence of approximately 2%–5% in women of reproductive age, can also be identified during pregnancy [1]. They have the potential to trigger both miscarriage and premature delivery [2,3], and their possible malignant transformation, which constitutes a significant clinical concern in reproductive medicine. We have consistently observed a notable association between cervical polyps in early pregnancy and subsequent occurrences of late miscarriage and preterm birth in obstetric practice. Cervical polyps in early pregnancy are a significant risk factor for spontaneous preterm birth (SPTB) in a retrospective study [3]. This raised concerns about polypectomy during pregnancy. However, opinions on whether to perform cervical polypectomy are different. According to a study that women who had cervical polypectomy during pregnancy had higher rates of SPTB compared with the general population [4]. Conversely, another study revealed that polypectomy procedures carry minimal risks of inducing miscarriage or preterm labor [5]. To date, the management of cervical polyps during pregnancy remains uncertain due to the lack of standardized clinical guidelines.

At our medical center, we observed that many women diagnosed in pregnancy of first trimester with cervical polyps exhibit higher rates of late miscarriage and SPTB. This pattern warrants investigation of a potential causal relationship. Notably, this study aimed to investigate the association between cervical polyps identified in early pregnancy and adverse pregnancy outcomes, specifically late miscarriage and SPTB (before 28, 34, or 37 weeks of gestation). Additionally, the study sought to evaluate the impact of cervical polypectomy on these pregnancy outcomes.

2. Materials and Methods

2.1 Patients

Patients were recruited from the Women's Hospital, Zhejiang University, between January 2021 and December 2021. The inclusion criteria were as follows: (1) Women aged $\geq$20 and $\leq$40 years old; (2) women who delivered vaginally. The exclusion criteria were as follows: (1) Fetal abnormality and multiple pregnancy; (2) placenta previa or placenta accreta spectrum disorders; (3) pregnancy complications, including hypertensive disorders of pregnancy, intrahepatic cholestasis of pregnancy, and acute fatty liver of pregnancy; (4) pregnancy complicated by internal or external medical conditions, such as heart diseases, diabetes mellitus, viral hepatitis, anemia, or thyroid diseases.

2.2 Evaluation

All patients underwent gynecological examination and transvaginal ultrasonography during early pregnancy. Other clinical information was also collected, including age, body mass index (BMI), reproductive history (gestation, parturition, abortion, and preterm birth), history of conization, vaginal bleeding, and bacterial vaginosis. The diagnosis of cervical polyps in early pregnancy (4–12 gestational weeks) was made through gross inspection by the clinician and transvaginal ultrasound evaluation, including assessment of polyp location, morphological features, and vascularity to exclude endocervical polyps. Cervical polyps are soft, elastic growths that arise from the endocervical canal. They can vary in size, ranging from a grain of rice to a thumbnail.

2.3 Interventions

The procedure settings were determined at the initiation of the case. In this retrospective study, women with cervical polyps in pregnancy of first trimester were categorized into a surgery group or a non-surgery group based on the interventions received. The surgical intervention comprised transvaginal cervical polypectomy. Before the procedure, the surgeon assessed each patient's condition by considering clinical symptoms and ultrasonography findings, particularly the location and morphology of the polyps. Patients presenting with more severe clinical manifestations—such as significant vaginal bleeding, symptomatic bacterial vaginosis, and easily accessible polyps—were more likely to undergo polypectomy. All surgeons participating in this study had received rigorous standardized training, had been similarly evaluated, and had more than five years of experience performing this procedure. All polyp specimens removed during polypectomy were subjected to standard histopathological examination.

2.4 Follow-ups

Cervical polyps were identified before 12 weeks of gestation. Prenatal assessments were conducted every 4 weeks until 28 weeks, every 2 weeks thereafter, and weekly from 36 weeks until delivery. The primary outcomes were gestational age at vaginal delivery and birth weight. Late abortion was clinically defined as spontaneous pregnancy loss occurring between 12 and 23 + 6 weeks of gestation. SPTB was defined as delivery occurring between 24 weeks and 36 + 6 weeks of gestation, resulting from either spontaneous onset of labor or preterm premature rupture of membranes, excluding medically indicated preterm deliveries. In addition, SPTB was divided into before 28 weeks, 34 weeks and 37 weeks. Because our hospital has limited capacity to rescue preterm births before 24 weeks of gestation, we excluded preterm births before 24 weeks.

2.5 Statistical Analysis

For descriptive analysis, proportions were used for categorical variables and means $\pm$ SD for continuous variables depending on their distribution. The confidence level of proportions for the categorical variables was 95%. Categorical variables were compared using the chi-square test and Yates' corrected chi-squared test was used instead of the chi-squared test when the value of a categorical variable was $<$5. Continuous variables with a normal distribution were compared using the independent *t*-test. Univariate and multivariate logistic regression analyses were performed to identify factors linked to late abortion or SPTB. The multivariate logistic regression model included only those variables that achieved statistical significance ($p < 0.05$) in preliminary univariate analyses. For consistency, statistics were rounded to two decimal places and *p*-values to three decimal places. A *p*-value < 0.05 was considered statistically significant. All statistical analyses were performed using IBM Statistical Package for the Social Sciences Statistics for Windows (version 25.0) (IBM Corp., Armonk, NY, USA, 2013).

3. Results

The recruitment process is illustrated in Fig. 1. The retrospective study included 10,344 women who delivered vaginally at the Women's Hospital, School of Medicine, Zhejiang University, between January 2021 and December 2021. Women with multiple pregnancies (n = 116), intrauterine fetal death (n = 63), major fetal malformations (n = 65), or major fetal complications (n = 110) were ruled out. The rest of 9990 women were enrolled in our study. They were divided into two groups: 94 women with cervical polyps in pregnancy of first trimester (P group) and 9896 women absence of cervical polyps (non-P group). Women with cervical polyps were further divided into the surgery group (n = 13) and the non-surgery group (n = 81). The baseline obstetric characteristics of these women are presented in Table 1. There was no significant difference between the non-polyp and polyp groups with respect to age, BMI, multipara, previous late-term abortion, SPTB before 34 weeks, or conization ($p > 0.05$). However, the incidence of bacterial vaginosis was significantly higher in the polyp group compared to the non-poly group ($p < 0.001$).

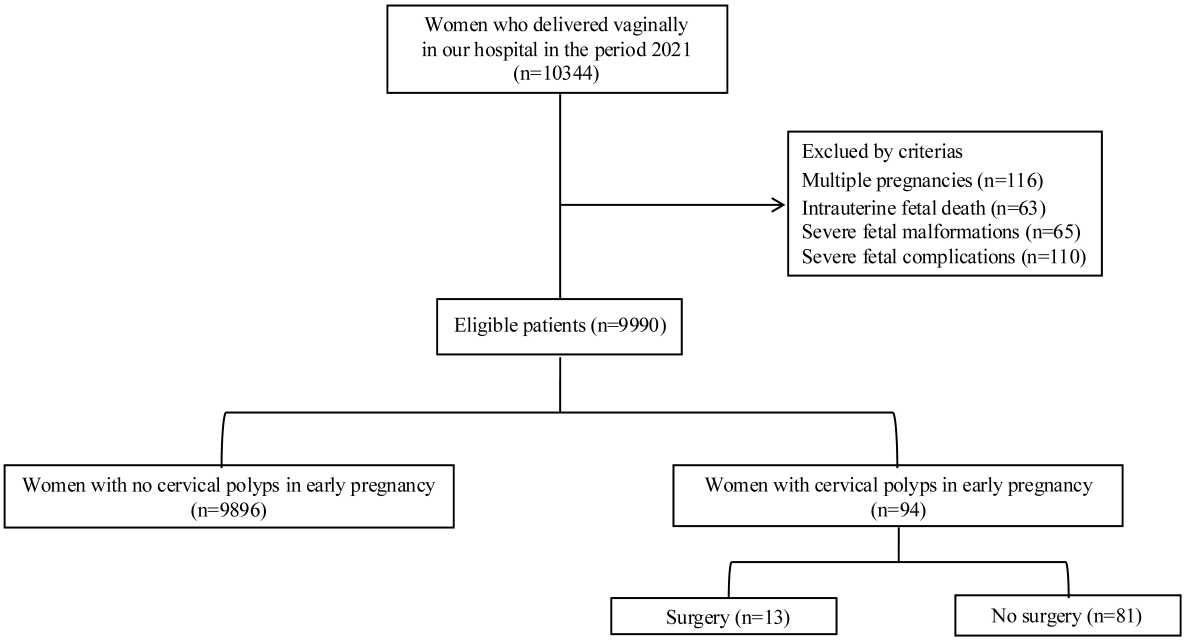

Fig. 1. Flowchart of patients' enrollment.

Table 1. Obstetric background information for groups with and without polyps.

Characteristics	Non-polyp (n = 9896)	Polyp (n = 94)	*p*
Age (years)	30.27 ± 3.80	30.95 ± 3.83	0.078
BMI (kg/m^2)	26.85 ± 4.94	25.09 ± 3.51	0.705
Parous	2785 (28.14)	24 (25.53)	0.575
Late-term abortion history	1000 (10.11)	8 (8.51)	0.609
History of spontaneous preterm birth (SPTB) before 34 weeks	900 (9.09)	7 (7.45)	0.580
History of conization	330 (3.33)	3 (3.19)	0.939
Bacterial vaginosis	231 (2.33)	8 (8.51)	<0.001**

Data are represented as means ± SD for continuous variables and as proportions for categorical variables.
**$p < 0.001$. BMI, body mass index.

Table 2. Pregnancy outcomes with or without cervical polyps.

Outcomes	Non-polyp (n = 9896)	Polyp (n = 94)	*p*
Gestational age at delivery, week	38.90 ± 1.48	33.46 ± 6.61	<0.001**
Birth weight, g	3273.21 ± 456.19	2365.28 ± 1127.22	<0.001**
Late abortion	12 (0.12)	12 (12.77)	<0.001**
SPTB before 28 weeks	16 (0.16)	8 (8.51)	<0.001**
SPTB before 34 weeks	55 (0.56)	16 (17.02)	<0.001**
SPTB before 37 weeks	205 (2.07)	15 (15.96)	<0.001**

Data are represented as means ± SD for continuous variables and as proportions for categorical variables.
**$p < 0.001$.

The comparison of pregnancy outcomes between the two groups is presented in Table 2. Both gestational age ($p < 0.001$) and neonatal birth weight ($p < 0.001$) were significantly lower in the polyp group than in the non-polyp group. Additionally, the incidence of late-term abortion ($p < 0.001$) and SPTB before 37 weeks ($p < 0.001$) was significantly higher in the polyp group compared with the non-polyp group.

We next compared factors associated with late abortion or SPTB by univariate and multivariate analyses as presented in Table 3. Logistic regression revealed that a late-term abortion history, previous SPTB before 34 weeks, and the presence of cervical polyps were significant risk factors for adverse pregnancy outcomes. Specifically, a late-term abortion history (OR: 62.14, 95% CI: 22.94–168.03, $p < 0.001$), previous SPTB before 34 weeks (OR: 14.05,

Table 3. Risk factors for late-term abortion or SPTB: univariate and multivariate analyses.

	Univariate analysis		Multivariate analysis	
	OR (95% CI)	*p*	OR (95% CI)	*p*
Late abortion				
Age	1.09 (0.93, 1.20)	0.093		
Parous	1.05 (0.40, 42.54)	0.909		
Late-term abortion history	74.32 (32.79, 168.47)	<0.001**	62.14 (22.94, 168.03)	<0.001**
Previous SPTB before 34 weeks	44.56 (17.20, 115.43)	<0.001**	14.05 (4.63, 42.60)	<0.001**
History of conization	0.00	0.997		
Bacterial vaginosis	3.73 (0.84, 15.96)	0.076		
Cervical polyps	120.54 (52.60, 276.20)	<0.001**	96.94 (34.88, 269.49)	<0.001**
SPTB before 28 weeks of pregnancy				
Age	1.04 (0.94, 1.15)	0.476		
Parous	1.83 (0.81, 4.12)	0.145		
Late-term abortion history	52.53 (23.17, 119.04)	<0.001**	33.11 (13.34, 82.22)	<0.001
Previous SPTB before 34 weeks	55.80 (22.47, 138.61)	<0.001**	24.59 (8.62, 70.21)	<0.001**
History of conization	11.67 (1.54, 88.67)	0.018**	0.94 (0.07, 12.89)	0.981
Bacterial vaginosis	5.89 (1.74, 19.88)	0.004**	5.93 (1.62, 21.67)	0.007*
Cervical polyps	57.44 (23.94, 137.74)	<0.001**	31.48 (11.48, 86.32)	<0.001**
SPTB before 34 weeks of pregnancy				
Age	1.02 (0.94, 1.06)	0.490		
Parous	1.39 (0.94, 2.27)	0.184		
Late-term abortion history	66.59 (40.57, 109.32)	<0.001**	63.40 (35.14, 114.39)	<0.001**
Previous SPTB before 34 weeks	64.44 (36.22, 114.63)	<0.001**	50.40 (23.24, 109.16)	<0.001**
History of conization	7.96 (1.88, 33.70)	0.005**	0.88 (0.09, 8.30)	0.914
Bacterial vaginosis	3.14 (1.25, 7.86)	0.015*	2.62 (0.90, 47.20)	0.062
Cervical polyps	36.70 (20.14, 66.85)	<0.001**	26.13 (11.58, 58.94)	<0.001**
SPTB before 37 weeks of pregnancy				
Age	0.94 (0.94, 1.03)	0.593		
Parous	0.93 (0.71, 1.29)	0.788		
Late-term abortion history	28.23 (19.76, 40.34)	<0.001**	25.13 (17.23, 36.66)	<0.001**
Previous SPTB before 34 weeks	25.64 (15.79, 41.65)	<0.001**	19.37 (11.12, 33.73)	<0.001**
History of conization	2.48 (0.59, 10.37)	0.213		
Bacterial vaginosis	1.48 (0.51, 2.61)	0.743		
Cervical polyps	8.94 (5.04, 15.86)	<0.001**	5.13 (2.59, 10.17)	<0.001**
Cervical cerclage				
Age	1.04 (0.94, 1.11)	0.209		
Parous	1.04 (0.61, 1.92)	0.774		
Late-term abortion history	57.42 (33.23, 99.19)	<0.001**	2.92 (0.74, 11.71)	0.135
Previous SPTB before 34 weeks	29.94 (14.54, 61.71)	<0.001**	4.53 (0.54, 38.13)	0.205
History of conization	15.71 (4.68, 52.64)	<0.001**	2.74 (0.51, 15.14)	0.367
Bacterial vaginosis	2.28 (0.71, 7.34)	0.167		
Cervical polyps	15.84 (6.98, 35.93)	<0.001**	1.50 (0.23, 14.33)	0.765

*$p < 0.05$, **$p < 0.001$.

95% CI: 4.63–42.60, $p < 0.001$), and the presence of cervical polyps (OR: 96.94, 95% CI: 34.88–269.49, $p < 0.001$) were identified as independent risk factors for late abortion. For SPTB before 28 weeks of pregnancy, independent risk factors included a late-term abortion history (OR: 33.11, 95% CI: 13.34–82.22, $p < 0.001$), previous SPTB before 34 weeks (OR: 24.59, 95% CI: 8.62–70.21, $p < 0.001$), bacterial vaginosis (OR: 5.93, 95% CI: 1.62–21.67, $p = 0.007$), and the presence of cervical polyps (OR: 31.48, 95% CI: 11.48–86.32, $p < 0.001$). A late-term abortion history (OR: 25.13, 95% CI: 17.23–36.66, $p < 0.001$), previous SPTB before 34 weeks (OR: 19.37, 95% CI: 11.12–33.73, $p < 0.001$), and the presence of cervical polyps (OR: 5.13, 95% CI: 2.59–10.17, $p < 0.001$) were independent risk factors for SPTB before 37 weeks. In contrast, no significant association was observed between cervical cerclage and pregnancy complicated by cervical polyps.

Table 4. Baseline characteristics of the polypectomy and non-polypectomy groups.

	Non-polypectomy group (n = 81)	Polypectomy group (n = 13)	*p*
Age (years)	30.74 ± 3.73	31.46 ± 3.69	0.520
BMI (kg/m^2)	25.16 ± 3.64	24.88 ± 3.02	0.789
Parous	20 (24.69)	5 (38.46)	0.207
Late-term abortion history	8 (9.88)	1 (7.69)	0.735
History of SPTB before 34 weeks	8 (9.88)	0 (0.00)	0.213
History of conization	5 (6.17)	0 (0.00)	0.195
Bacterial vaginosis	9 (11.11)	1 (7.69)	0.614
Vaginal bleeding	48 (59.26)	11 (84.62)	0.065
Polyp size (>1.2 cm)	38 (46.91)	10 (76.91)	0.045*
Polyp size (cm)	1.56 ± 1.15	2.09 ± 1.25	0.117
Cervical cervix ligature[#]	5 (6.17)	1 (7.69)	1.000

Data are represented as means ± SD for continuous variables and as proportions for categorical variables.

[#]Yates' corrected chi-squared test.

*$p < 0.05$.

Table 5. Pregnancy outcomes of the polypectomy and non-polypectomy groups.

	Non-polypectomy group (n = 81)	Polypectomy group (n = 13)	*p*
Gestational age at delivery, week	33.46 ± 6.57	33.85 ± 6.32	0.842
Birth weight, g	2370.14 ± 1127.70	2358.08 ± 1129.17	0.972
Late-term abortion	12 (14.81)	1 (7.69)	0.349
SPTB before 28 weeks of pregnancy	9 (11.11)	1 (7.69)	0.614
SPTB before 34 weeks of pregnancy	15 (18.52)	3 (23.08)	0.620
SPTB before 37 weeks of pregnancy	15 (18.52)	1 (7.69)	0.192

Data are represented as means ± SD for continuous variables and as proportions for categorical variables.

For further analysis, we compared pregnancy outcomes between the polypectomy group and the non-polypectomy group. The baseline characteristics of these women with cervical polyps in early pregnancy are presented in Table 4. No significant difference was observed between the two groups in age, BMI, parity, a late-term abortion history, previous SPTB before 34 weeks, previous conization, bacterial vaginosis, vaginal bleeding, polyp size, or cervical cervix ligature ($p > 0.05$). However, the proportion of polyps larger than 1.2 cm was significantly higher in the polypectomy group than in the non-polypectomy group ($p = 0.045$). The comparison of pregnancy outcomes between the two groups is presented in Table 5. No significant difference was found in gestational age or neonatal birth weight. Similarly, the incidence rate of late-term abortion, SPTB before 28 weeks, before 34 weeks, and before 37 weeks of pregnancy were also comparable between these two groups ($p > 0.05$).

Table 6 presents the risk factors for late abortion and SPTB in the presence of cervical polyps, confirmed by the univariate and the multiple logistic regression analyses. A late-term abortion history was an independent risk factor for the late-term abortion in these patients (OR: 7.03, 95% CI: 1.33–37.17, $p = 0.022$). Conversely, vaginal bleeding was identified as an independent protective factor for SPTB before 34 weeks in these patients (OR: 0.27, 95% CI: 0.09–0.83, $p = 0.023$). Additionally, no significant association was observed between polyp size, polypectomy and pregnancy outcomes complicated by cervical polyps ($p > 0.05$).

4. Discussion

Cervical polyps are common gynecologic conditions in reproductive-age women, typically arising from glandular epithelial hyperplasia and are commonly benign. To our knowledge, the association between the cervical polyps detected before 12 weeks of gestation and reproductive outcomes has not been well elucidated, and no standardized clinical pathways exist for managing cervical polyps during pregnancy. This study included a large cohort of women who delivered vaginally with or without complications from cervical polyps, and followed their reproductive outcomes—specifically gestational age and birth weight, which are crucial factors for couples preparing for childbirth.

In our study, we identified that cervical polyps in early pregnancy negatively impacted pregnancy outcomes, as reflected in gestational age and birth weight, consistent with previous studies [2–4]. Furthermore, we demonstrated that a late-term abortion history, previous SPTB before 34 weeks, and the presence of cervical polyps were independent risk factors for late-term abortion and SPTB occurring before 28, 34, and 37 weeks, respectively. In addition, bacterial vaginosis was an obvious independent risk factor for SPTB before 28 weeks.

Table 6. Risk factors for the late-term abortion and SPTB in women with cervical polyps: univariate and multivariate analyses.

	Univariate analysis		Multivariate analysis	
	OR (95% CI)	*p*	OR (95% CI)	*p*
Late abortion				
Age	1.09 (0.93, 1.30)	0.272		
Parous	1.11 (0.27, 4.58)	0.889		
Late-term abortion history	7.03 (1.33, 37.17)	0.022*	7.03 (1.33, 37.17)	0.022*
Previous SPTB before 34 weeks	4.17 (0.67, 26.05)	0.127		
History of conization	0.00	1.000		
Bacterial vaginosis	0.00	0.991		
Vaginal bleeding	1.02 (0.27, 3.77)	0.982		
Polyp size (>1.2 cm)	2.88 (0.71, 11.64)	0.139		
Polypectomy	0.57 (0.07, 4.77)	0.594		
SPTB before 28 weeks of pregnancy				
Age	1.09 (0.90, 1.32)	0.358		
Parous	1.86 (0.41, 8.48)	0.423		
Late-term abortion history	1.81 (0.19, 17.24)	0.606		
Previous SPTB before 34 weeks	2.20 (0.23, 21.56)	0.498		
History of conization	5.71 (0.46, 71.14)	0.176		
Bacterial vaginosis	1.53 (0.16, 14.29)	0.709		
Vaginal bleeding	4.48 (0.53, 38.14)	0.170		
Polyp size (>1.2 cm)	7.72 (0.91, 65.58)	0.061		
Polypectomy	0.83 (0.09, 7.39)	0.870		
SPTB before 34 weeks of pregnancy				
Age	0.98 (0.84, 1.14)	0.793		
Parous	0.96 (0.28, 3.35)	0.955		
Late-term abortion history	4.04 (0.81, 20.19)	0.088		
Previous SPTB before 34 weeks	2.50 (0.47, 15.03)	0.316		
History of conization	2.43 (0.20, 28.21)	0.486		
Bacterial vaginosis	1.62 (0.29, 8.87)	0.579		
Vaginal bleeding	0.27 (0.09, 0.83)	0.023*	0.27 (0.09, 0.83)	0.023*
Polyp size (>1.2 cm)	0.37 (0.12, 1.16)	0.087		
Polypectomy	1.48 (0.36, 6.12)	0.591		
SPTB before 37 weeks of pregnancy				
Age	1.00 (0.86, 21.57)	0.989		
Mul parous	0.74 (0.19, 3.02)	0.701		
Late-term abortion history	0.00	1.000		
Previous SPTB before 34 weeks	1.09 (0.12, 10.13)	0.938		
History of conization	0.00	1.000		
Bacterial vaginosis	0.76 (0.09, 6.69)	0.803		
Vaginal bleeding	1.05 (0.32, 3.44)	0.936		
Polyp size (>1.2 cm)	0.68 (0.21, 2.13)	0.503		
Polypectomy	0.41 (0.05, 3.44)	0.411		

*$p < 0.05$.

We hypothesized that the elevated risk of miscarriage and preterm delivery in patients with cervical polyps may be mediated by the following mechanisms. First, cervical polyps may trigger chronic inflammation in the cervical and uterine microenvironment, stimulating pro-inflammatory mediators [for example, interleukin (IL)-6, tumor necrosis factor-α (TNF-α), and prostaglandins] [6]. Previous studies have demonstrated that pregnant women with cervical polyps exhibited significantly elevated levels of cervical mucus granulocyte elastase activity and leukocyte infiltration compared to those without polyps [7]. Immunohistochemical analyses further confirmed that these inflammatory mediators migrated from stromal tissue to the cervical canal, providing strong evidence that cervical polyps provoked localized inflammatory responses there [8]. This inflammatory cascade promoted premature cervical ripening and uterine contractions, significantly increasing the risk of preterm birth [6]. The persistent inflammation may

also create a self-perpetuating cycle of tissue remodeling and inflammatory response, further exacerbating the process. However, direct evidence establishing inflammatory pathways as the mechanistic link between cervical polyps and adverse pregnancy outcomes remains lacking in our study and requires further investigation. Second, the presence of cervical polyps may undermine the structural integrity of the cervix, impairing its barrier function and increasing vulnerability to ascending infection or premature dilation [2,5]. Additionally, cervical polyps may serve as a reservoir for microbial colonization, promoting the migration of pathogenic bacteria into the upper genital tract. This process increased the risk of intrauterine infections or chorioamnionitis, which triggered inflammatory cells to release proteases that degraded fetal membranes, ultimately leading to membrane rupture, labor initiation, and preterm birth [4]. In addition, the cervical environment altered by cervical polyps may contribute to cervical erosion and a compromised defense against infection, which explains the increased likelihood of bacterial vaginitis in pregnant women with cervical polyps, thereby creating a vicious cycle.

In this study, a history of cervical conization was not identified as a risk factor for late-term miscarriage or SPTB, but this conclusion may be subject to potential bias. This is because our analysis only included data on cervical cerclage among patients with cervical polyps, without a comprehensive statistical comparison of cervical cerclage status in most patients without polyps. A late-term abortion history and previous SPTB were identified as independent risk factors for the recurrence of late-term abortion and SPTB in the current gestation. No significant association was found between the placement of cervical cerclage and the following factors: A late-term abortion history, occurrence of SPTB before 34 weeks of gestation, previous cervical conization procedures, or presence of cervical polyps. The main causes of late miscarriage include cervical insufficiency, infections, structural abnormalities of the uterus, placental disorders, fetal anomalies, endocrine disturbances, immune factors, and adverse lifestyle behaviors. SPTB is primarily caused by preterm labor (accounting for 40%–50% of cases) or premature rupture of membranes (20%–30%) and occasionally by cervical insufficiency or placental abruption. However, we did not conduct a detailed individual analysis of these specific factors, which may introduce potential biases into our findings. Previous research has demonstrated that cervical polyps served as significant risk factors of cervical incompetence, often necessitating cerclage of the cervix [9]. According to international clinical guidelines, cervical cerclage is recommended for singleton pregnancies in cases with previous SPTB before 34 weeks coupled with cervical length shortening to less than 25 mm before 24 weeks [10]. Further robust, large-scale research is warranted to optimize cervical cerclage strategies and evaluate their efficacy in improving perinatal outcomes, with a focus on patient selection criteria, timing of intervention, and long-term maternal and neonatal benefits.

Currently, treatment approaches vary due to the lack of standardized guidelines for cervical polyps in early pregnancy. In clinical practice, polypectomy is considered in cases of heavy vaginal bleeding, secondary infection, excessively long polyps or prolapse at the vaginal orifice, or highly suspected cervical malignant transformation. These criteria also guided the surgical indications in this study.

Our results revealed no significant correlation between undergoing polypectomy or polyp size in pregnancy and the occurrence of the late-term abortion or SPTB. In contrast, the proportion of cervical ligature was comparable between the polypectomy and non-polypectomy groups. Several studies have suggested that polypectomy during pregnancy may adversely affect pregnancy outcomes [4]. Similarly, Zhang *et al*. [11] highlighted that the use of vaginoscopy reduced the incidence of preterm birth and premature rupture of membranes compared to conventional polypectomy techniques in women with symptomatic cervical polyps. Notably, the timing of polypectomy may be a critical factor influencing clinical outcomes. Fukuta *et al*. [4] reported that polypectomy at $\leq$10 weeks was an independent risk factor for predicting delivery before 34 weeks. In this study, the average gestational age at which polypectomy was performed was 18.8 weeks. Furthermore, previous studies have suggested that cervical polyps larger than 12 mm combined with vaginal bleeding were predictors of preterm labor, but we found no significant association between cervical polyps exceeding 12 mm and late abortion or spontaneous preterm labor [4]. This discrepancy may be attributed to potential biases, including substantial differences in polyp size between the polypectomy and non-polypectomy groups, as well as the limited number of patients with cervical polyps in this study. Moreover, the significant disparity in group sizes between the polypectomy (n = 13) and non-polypectomy (n = 81) cohorts may limit our ability to fully characterize the effects of the intervention. Overall, due to the limited follow-up duration and relatively small sample size, further comprehensive studies are essential to determine whether cervical polyps during pregnancy should be excised and to establish optimal management protocols.

We observed that vaginal bleeding emerged as an independent protective factor against SPTB before 34 weeks of gestation in patients with cervical polyps. This unexpected finding, which deviates from conventional clinical expectations, may be explained by heightened clinical vigilance and the more aggressive tocolytic interventions typically employed when managing patients with cervical polyps accompanied by vaginal bleeding. It is also possible that the sample size of patients with pregnancy complicated by cervical polyps in this study was relatively small, leading to potential deviations. Further large-scale, prospective studies are warranted to validate the precise impact of vaginal

bleeding on pregnancy outcomes and to establish evidence-based clinical guidelines for its management in antenatal care.

Our observed cervical polyp prevalence of 0.94% was indeed lower than population estimates, while the 54.25% adverse outcome rate appeared elevated. This may be partially attributed to the experience of the initial examining physician, as cervical polyps can occasionally be misidentified as simple inflammatory hyperplasia during routine gynecological examination, resulting in missed diagnoses. However, even when the cervix was solely inflamed or when polyps spontaneously resolved or were no longer visible during pregnancy, these conditions may still elevate the risk of late miscarriage and SPTB [2]. That's to say, non-bleeding polyps may have been misclassified as inflammatory changes during initial exam. On the other hand, symptomatic patients were more likely to be referred to our tertiary center. The differences in prevalence and outcome rates likely reflected selection bias inherent in our clinical cohort. Besides, our primary inclusion criterion was vaginal delivery, with subsequent stratification into polyp (n = 94) and non-polyp (n = 9896) groups based on documented clinical and ultrasound findings. The lack of polyp size/symptom specifications represents a study limitation, which might introduce a degree of selection bias and manifest as a crucial limitation. Specifically, the proportion of polyps larger than 1.2 cm in the polypectomy group was significantly higher than that in the non-polypectomy group (p = 0.045). To mitigate the influence of confounding factors, we conducted a multivariate logistic analysis to explore factors associated with late abortion and SPTB, thereby improving accuracy and reliability by simultaneously considering multiple variables affecting the outcomes. We adjusted for obstetric history and vaginal bleeding in the multivariate analysis, while other potential confounding were unmeasured, such as cervical inflammation, intrauterine infection, cervical incompetence. Further rigorous contrivable studies are required to verify our findings and the impact of these factors on reproductive outcomes in patients with cervical polyps.

This study has some limitations. First, existing evidence from prior studies indicates a potential association between cervical polyps during pregnancy and increased susceptibility to cervical incompetence in specific female populations. Unfortunately, we did not investigate the cervical lengths, Bishop scores, and cervical cerclage among these patients, which limited our capacity to thoroughly evaluate the potential impact of cervical polyps on cervical function. Moreover, the degree of cervical inflammation was not quantified or assessed using specific inflammatory markers, such as IL-6 and TNF-α. Second, emerging evidence from recent studies has consistently revealed a significant association between different polyp subtypes and an increased risk of preterm delivery. Specifically, pregnant patients undergoing polypectomy with decidual polyps demonstrated a significantly higher risk of abortion and preterm delivery compared to those with endocervical polyps [5,12]. In this study, the histopathological analysis in our study revealed that among patients undergoing polypectomy, 61.5% (8/13) were diagnosed with decidual polyps, while the remaining 38.5% (5/13) exhibited cervical polyps. Prospective studies with larger sample sizes should systematically stratify pregnancy outcomes according to specific polyp characteristics to enhance the clinical relevance of the findings. Third, pregnancies conceived through assisted reproductive technology may carry an increased risk of SPTB, even in the absence of multiple gestation [3]. We did not examine the pregnancy patterns in the baseline characteristics analysis; thus, some confounding bias may exist. Additionally, this study has inherent limitations as a single-center retrospective analysis with a small surgical cohort (n = 13 polypectomies), which introduced selection and recall biases and limits its generalizability.

5. Conclusions

In summary, our findings suggested that cervical polyps detected in the first trimester significantly compromise pregnancy outcomes, as evidenced by reduced gestational age, increased late miscarriage and SPTB, and lower birth weight. Notably, subsequent polypectomy intervention failed to mitigate these adverse effects. An adequately powered randomized controlled trial is required to confirm our findings and to conduct a more comprehensive evaluation of the factors influencing clinical decision-making, including baseline clinical presentations, polyp characteristics (such as size, morphology, and location) and detailed histopathological subtypes.

Availability of Data and Materials

The data that support the findings of this study are not publicly available due to privacy reason but are available from the corresponding author upon reasonable request.

Author Contributions

Concept or design: TF; Acquisition of data: TF, TW; Analysis or interpretation of data: TF, TW; Drafting of the article: TF, TW; Critical revision for important intellectual content: TF. Both authors contributed to editorial changes in the manuscript. Both authors read and approved the final manuscript. Both authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was carried out in accordance with the guidelines of the Declaration of Helsinki and was approved by the Ethics Committee of Women's Hospital, Zhejiang University School of Medicine (no. IRB-20230022-R). The written consent was signed by the patients or their families.

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Conflict of Interest

The authors declare no conflict of interest.

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