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Original Article

Effects of hysteroscopic cold knife technique on the treatment of endometrial polyps and its protective effect on the endometrium

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Abstract: Objective: To explore the effects of hysteroscopic cold knife technology in the treatment of endometrial polyps and its protective effect on the endometrium. Methods: This retrospective study included 106 patients with endometrial polyps admitted to Jiashan County Second People's Hospital between January 2019 and August 2023. The patients were divided into an observation group and a control group based on their treatment model, with 53 cases in each. The control group was treated with hysteroscopic electrosurgery, and the observation group was treated with hysteroscopic cold knife technology. Perioperative conditions, inflammatory factor levels (C-reactive protein (CRP), tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6)), uterine artery resistance index (RI), pulsatility index (PI), endometrial thickness, estrogen receptor (ER) and progesterone receptor (PR) levels, the incidences of postoperative complications, and recurrence rates were compared between the two groups. Results: In the observation group, the operation time, intraoperative blood loss, postoperative vaginal bleeding duration, postoperative vaginal bleeding volume, hospital stays and hospital costs were (20.87±3.02) min, (19.84±2.63) mL, (2.45±0.38) d, (2.69±0.53) mL, (4.57±0.85) d, and (719.54±78.23) dollars, respectively, all of which were significantly lower than those in the control group (all $P<0.001$). At 1 month postoperatively, serum CRP, TNF-α, and IL-6 levels in the observation group were (4.21±0.32) mg/L, (45.04±4.62) ng/L, and (64.38±5.29) pg/m/L, respectively, all significantly lower than those in the control group (all $P<0.001$). At 3 months postoperatively, the RI, PI and endometrial thickness in the observation group were (0.68±0.13), (0.84±0.16), and (5.59±0.73) mm, respectively, all significantly lower than those in the control group (all $P<0.001$). At 3 months postoperatively, ER and PR were (1.68±0.21) U/L and (0.97±0.19) U/L in the observation group, respectively, which were lower than those in the control group. No statistically significant differences in complication rates were observed between the two groups. The recurrence rate in the observation group was 3.77%, which was lower than that in the control group. Conclusion: Hysteroscopic cold knife technology is an effective and minimally invasive treatment for endometrial polyps, with rapid postoperative recovery and protective effects on the endometrium.

Keywords: Endometrial polyp, hysteroscopic cold knife technique, hysteroscopic electrosurgery, complications, effects

Introduction

Endometrial polyps are a common gynecology condition characterized by the overgrowth of endometrial cells, resulting in the formation of redundant tissue on the surface of the endometrium. Its pathogenesis is multifactorial, involving hormonal disorders, local inflammation, metabolic disturbances, and genetic mutations [1, 2]. Patients with endometrial polyps may experience symptoms such as irregular vaginal bleeding, increased menstrual flow, and prolonged menstrual period, which can lead to infertility and negatively impact quality of life [3, 4]. Therefore, it is crucial to select an effective treatment to treat patients with endometrial polyps.

At present, endometrial polyps are primarily treated by surgery, with scraping and clamping being common methods. In recent years, with the development of minimally invasive surgical instruments and in-depth study of the disease, the application of hysteroscopic endometrial polypectomy has gradually increased, offering distinct advantages [5]. Hysteroscopy is considered the gold standard for the treatment of endometrial polyps, as it allows for direct visualization of the uterine cavity and targeted removal of diseased tissue. In the hysteroscopic surgery, electrosurgical resection is typically used, using electrocautery equipment to excise the polyp tissue while simultaneously observing the uterine cavity [5, 6].

However, electrosurgery may cause unnecessary damage to the endometrial tissue, potentially affecting early postoperative recovery. Some studies have shown that electrosurgery using ring electrodes for polyp tissue removal and electrocoagulation for hemostasis generate thermal radiation that can damage surrounding normal tissues, increasing the risk of postoperative uterine adhesion and limiting the effectiveness of surgical treatment [7, 8]. In contrast, hysteroscopic cold knife technology utilizes mechanical cutting rather than electrical energy for tissue resection, which offers several benefits, including greater precision, shorter operation time, and less tissue damage. However, the effectiveness of hysteroscopic cold knife technique in treating endometrial polyps and its protective effects on the endometrium remain unclear. Moreover, there is a lack of studies comparing the outcomes of hysteroscopic electrotomy and cold knife resection in the treatment of endometrial polyps.

This clinical study was designed to explore the efficacy and safety of the hysteroscopic cold knife resection in the treatment of endometrial polyps, with a focus on perioperative outcomes, inflammation factors, endometrium protection, and complications. The findings of this study will provide valuable insights and references for the treatment of endometrial polyps.

Material and methods

General information

This retrospective study was conducted in patients with endometrial polyps treated at Jiashan County Second Peoples Hospital between January 2019 and August 2023. This study was approved by the Ethics Committee of Jiashan County Second People's Hospital (Approval number: No. 2025-1217).

Inclusion criteria: (1) Patients who met the diagnostic criteria for endometrial polyps [9]; (2) Patients classified as American Society of Anesthesiologists (ASA) classification I-II; (3) Patients who had not previously undergone treatment for endometrial polyps; (4) Patients with complete clinical data. Exclusion criteria: (1) Patients with coexisting uterine or ovarian diseases; (2) Patients with multiple organ dysfunction syndrome; (3) Patients with coagulation disorders; (4) Patients who had received hormone therapy recently; (5) Patients with malignant tumors or mental abnormalities, such as cognitive disorders.

According to the inclusion criteria and exclusion criteria, 106 patients with endometrial polyps were recruited in this study, and their clinical data were retrospectively analyzed. Based on the treatment methods, these patients were assigned into the control group and the observation group, with 53 patients in each. Patients in the control group were treated with hysteroscopic electrotomy, while those in the observation group were treated with the hysteroscopic cold knife resection.

Methods

All surgeries were completed by the same group of surgeons. The control group was treated with hysteroscopic electrosurgery, as follows: (1) the patient was placed in the lithotomy position, and the operation was performed under general anesthesia, with routine disinfection and draping. Uterine expansion was achieved using 0.9% saline at a flow rate of 280-320 mL/min, maintaining an expansion pressure of 13.1-13.4 kPa; (2) after dilating the cervix to 9-10 cm, hysteroscopic instruments were inserted to observe the size, number, location, and shape of the endometrial polyps. The bipolar electrodes system was used to carefully remove the polyps near the mucosal layer. In case of a single polyp, the polyp was removed along with its root tip to ensure the complete excision. In cases of multiple polyps, only the superficial endometrial layer was removed.

Patients in the observation group were treated with hysteroscopic cold knife technology, as follows: (1) The patient was placed in the lithotomy position, and the procedure was performed under general anesthesia, with routine disin-

Table 1. Comparison of general data between the two groups [Mean ± SD, n (%)]

Groups	Cases	Age (years)	BMI (kg/m^2)	Course of disease (years)	Number of polypus	Diameter of polypus (cm)
Observation group	53	36.83±7.40	22.87±2.59	3.06±0.68	1.98±0.43	2.57±0.64
Control group	53	37.11±6.95	22.75±2.64	3.17±0.63	2.02±0.49	2.52±0.58
χ^2/*t* value		0.201	0.236	0.864	0.447	0.421
P value		0.841	0.814	0.390	0.656	0.674

Note: BMI: Body mass index.

fection and draping. Uterine expansion was achieved using 0.9% saline at a flow rate of 280-320 mL/min, maintaining an expansion pressure of 13.1-13.4 kPa; (2) Hysteroscopic instruments were inserted, and the size, number, location, and morphology of the endometrial polyps were observed. The hysteroscopic cold knife was used to remove the polyp tissue from the root, carefully adhering to the uterine mucosal layer.

Both groups received routine postoperative anti-infective treatment and oral dexamethasone tablets (specification: 10 mg; Abbott Biologicals B.V, Netherlands; Lot Number: 20170221). The dosage was 10 mg twice a day, starting on the 1st day of the menstrual cycle, continuing for 21 consecutive days, and then stopping for 7 days. This treatment was administered for 2 menstrual cycles.

Observation indicators

(1) Perioperative conditions: operation time, intraoperative blood loss, postoperative vaginal bleeding duration, postoperative vaginal bleeding volume, hospital stay, and hospitalization expenses. (2) Inflammatory factors: fasting venous blood (5 mL) was collected from both groups before and one week after operation. The blood samples were processed by routine centrifugation at 3,200 r/min for 10 minutes, and the upper serum was collected for analysis. The following inflammatory markers were measured using enzyme-linked immunosorbent assay (ELISA), as previously reported [10]: C-reactive protein (CRP) (Lot number: ab260058, Abcam Limited, USA), tumor necrosis factor-alpha (TNF-alpha) (Lot number: ab181421, Abcam Limited, USA) and interleukin-6 (IL-6) (Lot number: ab178013, Abcam Limited, USA). (3) Uterine artery blood flow and endometrial thickness: vaginal color Doppler ultrasonography (Nanjing Beden Medical Co., Ltd., model DC-N2S) was used to measure the uterine artery resistance index (RI), pulsatility index (PI), and endometrial thickness preoperatively and at 3 months postoperatively. (4) Estrogen and progesterone: endometrial tissues were collected preoperatively and at 3 months postoperatively. The changes in estrogen receptor (ER) and progesterone receptor (PR) levels were measured by ELISA, as described in previous reports [11]. (5) Complications: The incidences of postoperative complications, including uterine adhesion, abdominal pain, interstitial bleeding, and infection, were compared between the two groups. (6) Recurrence rate: All patients were followed up for 12 months, and the recurrence rate of uterine polyps was recorded.

Statistical methods

Data were analyzed using SPSS software (IBM, USA), version 22.0. Measurement data were expressed as Mean ± standard deviation (SD). Comparisons between the two groups were performed through independent samples t-tests. Enumeration data were presented as frequency and percentage [n (%)]. The comparisons between the two groups were conducted using Chi-square tests. $P<0.05$ was considered statistically significant.

Results

Comparison of general information between the two groups

No significant differences were observed between the two groups in terms of age, BMI (body mass index), course of disease, number of polyps, and polyp diameter (all $P>0.05$; **Table 1**), indicating that the groups were comparable.

Table 2. Comparison of perioperative indexes between the two groups [Mean ± SD, n (%)]

Groups	Cases	Operation time (min)	Intraoperative blood loss (mL)	Postoperative vaginal bleeding duration (d)	postoperative vaginal bleeding volume (mL)	Hospital stays (d)	Hospitalization expenses (US dollars)
Observation group	53	20.87±3.02	19.84±2.63	2.45±0.38	2.69±0.53	4.57±0.85	719.54±78.23
Control group	53	31.47±4.52	34.68±3.75	3.42±0.57	3.88±0.65	5.42±1.02	830.95±103.71
t value		14.196	23.587	10.308	10.330	4.661	5.017
P value		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Comparison of perioperative indexes between the two groups

In the observation group, operation time, intraoperative blood loss, postoperative vaginal bleeding duration, postoperative vaginal bleeding volume, hospital stays, and hospitalization expenses were 20.87±3.02 min, 19.84±2.63 mL, 2.45±0.38 days, 2.69±0.53 mL, 4.57±0.85 days, and 719.54±78.23 dollars, respectively. These values were significantly lower than those in the control group (all P<0.001), as shown in **Table 2**.

Comparison of inflammatory factors between the two groups

As shown in **Table 3**, there were no significant differences in the serum levels of CRP, IL-6 and TNF-α between the two groups before surgery (P>0.05). At 1 month after surgery, the levels of CRP, IL-6, and TNF-α levels in the observation group were significantly lower than those in the control group (all P<0.001).

Comparison of uterine artery blood flow and endometrial thickness between the two groups

As shown in **Table 4**, there were no significant differences in uterine artery blood flow and endometrial thickness between the two group before surgery (P>0.05). However, uterine artery blood flow indexes, including RI and PI, and endometrial thickness, were significantly reduced after surgery in both groups (all P<0.05). In addition, the post-surgery RI and PI, and endometrial thickness in observation group were markedly lower than those in control group (all P<0.001). Typical ultrasound images from both groups before and after surgery are displayed in **Figure 1**.

Comparison of estrogen and progesterone levels between the two groups

As shown in **Table 5**, there were no significant differences in estrogen and progesterone receptor levels between the control and observation groups before surgery (P>0.05). However, at 3 months postoperatively, the levels of estrogen and progesterone in the observation group were significantly lower than those in the control group (all P<0.001).

Comparison of incidences of postoperative complications between the two groups

As shown in **Table 6**, in the control group, there were three cases of intrauterine adhesion, two cases of abdominal pain, two cases of bleeding, and one case of infection. In the observation group, there was one case of intrauterine adhesion, one case of abdominal pain, one case of bleeding, and no cases of infection. The overall incidence of postoperative complications in the observation group was slightly lower than that in the control group (5.66% vs 16.98%, P=0.111).

Comparison of recurrence rate between the two groups

As shown in **Table 7**, during the follow-up period, the recurrence rate in the observation group was 3.77% (2/53), while it was 15.09% (8/53) in the control group (χ^2=3.975, P=0.045).

Discussion

Endometrial polyps are common benign nodular lesions of the endometrium, occurring in both reproductive-age and menopausal women. If left untreated, these polyps grow continuously, further diminishing the patient's quality of life [12, 13]. Some endometrial polyps carry the risk of malignant transformation and should be closely monitored in clinical practice [14, 15]. The pathogenesis of endometrial polyps is multifactorial. One of the key factors is estrogen imbalance. Excessive estrogen response can cause persistent local stimulation, resulting in excessive endometrial hyperplasia and the formation of polyps. Additionally,

Table 3. Comparison of inflammatory factors between the two groups (Mean ± SD)

Groups	Cases	CRP (mg/L)			TNF-α (ng/L)			IL-6 (pg/mL)		
		Before surgery	At 1 m after surgery	t/*P* value	Before surgery	At 1 m after surgery	t/*P* value	Before surgery	At 1 m after surgery	t/*P* value
Observation group	53	7.53±0.63	4.21±0.32	34.210/<0.001	65.85±6.29	45.04±4.62	19.410/<0.001	80.21±6.54	64.38±5.29	13.700/<0.001
Control group	53	7.69±0.85	5.49±0.39	17.130/<0.001	67.52±7.54	58.19±5.34	7.351/<0.001	82.34±8.57	73.34±7.58	5.727/<0.001
t value		1.101	18.470		1.238	13.560		1.438	7.057	
P value		0.274	<0.001		0.218	<0.001		0.153	<0.001	

Note: CRP: C-reactive protein; TNF-alpha: Tumor necrosis factor-alpha; IL-6: Interleukin-6.

Table 4. Comparison of uterine artery blood flow indices and endometrial thickness between the two groups (Mean ± SD)

Groups	Cases	RI			PI			Endometrial thickness (mm)		
		Before surgery	3 months after surgery	t/*P* value	Before surgery	3 months after surgery	t/*P* value	Before surgery	3 months after surgery	t/*P* value
Observation group	53	1.23±0.27	0.68±0.13	13.360/<0.001	1.56±0.34	0.84±0.16	13.950/<0.001	13.05±0.58	5.59±0.73	58.250/<0.001
Control group	53	1.18±0.30	0.81±0.16	7.922/<0.001	1.61±0.30	1.06±0.23	10.590/<0.001	13.11±0.54	7.13±0.62	52.950/<0.001
t value		0.902	4.591		0.803	5.716		0.551	11.706	
P value		0.369	<0.001		0.424	<0.001		0.583	<0.001	

Note: RI: Resistance index; PI: Pulsatility index.

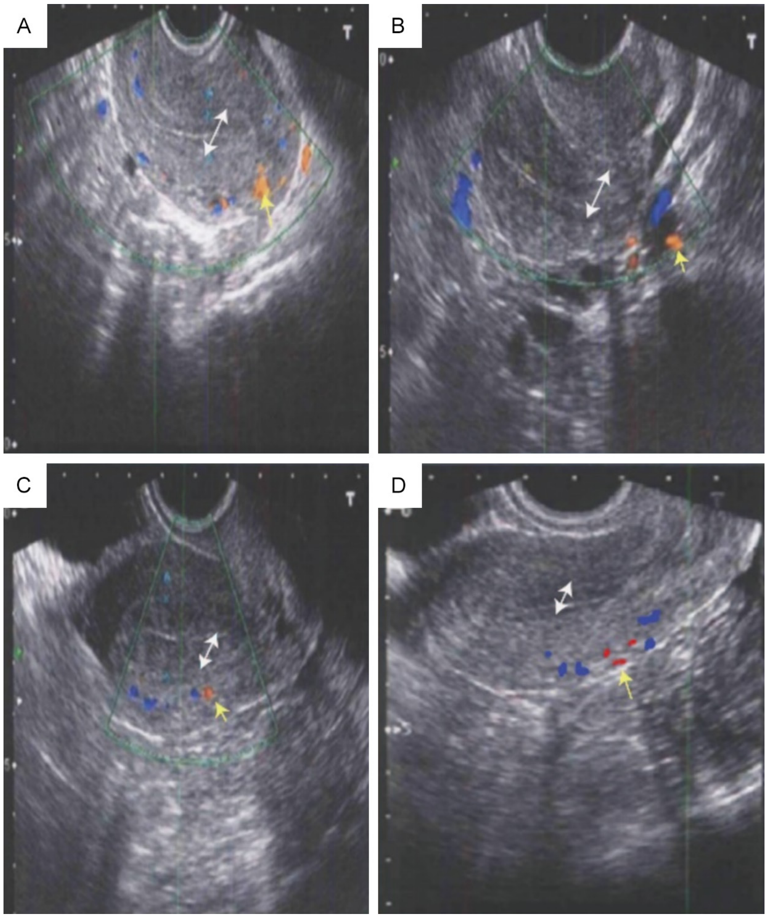

Figure 1. Color Doppler ultrasonographic images. A: Before surgery (control group). B: Before surgery (observation group). C: Three months after surgery (control group). D: Three months after surgery (observation group). Double-headed arrow: Endometrial thickness; Yellow arrow: Blood flow of uterine arterial.

local inflammatory response in the endometrium can trigger abnormal repair and hyperplasia, contributing to polyp growth. Genetic mutations and chromosomal abnormalities may also play a role in the formation of endometrial polyps [16, 17]. Obesity is another risk factor, as it leads to increased estrogen levels due to adipose tissue converting androgens into estrogens, which in turn promotes endometrial proliferation. Obesity is also associated with insulin resistance and chronic low-grade inflammation, which may promote polyp formation [18]. These factors, working through different mechanisms, promote localized abnormal endometrial proliferation, ultimately leading to polyp formation.

Surgery remains the main treatment for endometrial polyps. Historically, curettage and hysterectomy were the main surgical options. However, curettage has a lower success rate in removing polyps and a higher recurrence rate later in life, while hysterectomy can lead to infertility, greatly impacting both the physiological and psychological well-being of the patient. As a result, these methods are now less commonly used in clinical practice. With advancements in medical technology, minimally invasive surgery via hysteroscopy has become the mainstream treatment for endometrial polyps, enabling complete removal of polyps while preserving the uterus, with improved safety and efficacy [5, 19]. Hysteroscopic cold knife technology has been successfully applied to various intrauterine stations, such as uterine adhesion and fibroids, demonstrating positive clinical outcomes [20, 21].

The results of this study showed that patients treated with hysteroscopic cold knife technique experienced shorter operation time, less intraoperative blood loss, reduced postoperative vaginal bleeding duration and volume, shorter hospital stays, and lower hospitalization costs. Additionally, postoperative serum levels of CRP, TNF-α, and IL-6 were lower in the observation group. The possible reason is that, hysteroscopic electrosurgery, which requires electrocoagulation for hemostasis, often prolongs the operation time. The use of electrodesiccation can generate thermal damage, leading to intraoperative tissue edema and increased perfusion, which increases intraoperative bleeding and exacerbates post-operative inflammatory reactions, thereby prolonging recovery. In contrast, the hysteroscopic cold knife technique, with a diameter of approximately 5.4 mm, can be used without cervix dilation and does not require electric energy during tissue excision. This avoids the thermal damage to tissues, prevents smoke and carbonized tissue formation,

Table 5. Comparison of estrogen and progesterone levels between the two groups

Groups	Cases	ER (U/L)			PR (U/L)		
		Before surgery	3 months after surgery	t/*P* value	Before surgery	3 months after surgery	t/*P* value
Observation group	53	2.20±0.39	1.68±0.21	8.547/<0.001	1.72±0.33	0.97±0.19	14.340/<0.001
Control group	53	2.13±0.47	1.89±0.30	3.134/0.002	1.69±0.38	1.26±0.24	6.965/<0.001
t value		0.834	4.175		0.434	6.897	
P value		0.406	<0.001		0.665	<0.001	

Note: ER: Estrogen receptor; PR: Progesterone receptor.

Table 6. Comparison of incidences of postoperative complications between the two groups [n (%)]

Groups	Cases	Intrauterine adhesion	Abdominal pain	Bleeding	Infection	The overall incidence [n (%)]
Observation group	53	1 (1.89)	1 (1.89)	1 (1.89)	0 (0.00)	3 (5.66)
Control group	53	3 (5.66)	2 (3.77)	2 (3.77)	1 (1.89)	8 (16.98)
χ^2 value						2.536
P value						0.111

Table 7. The comparison of recurrence rate between the two groups

Groups	Recurrence rate [n (%)]
Control group	8/53 (15.09%)
Observation group	2/53 (3.77%)
χ^2 value	3.975
P value	0.045

and enhances the clarity of the surgical field, making the procedure smoother and more precise. As a result, the operation time is shortened, unnecessary tissue damage is minimized, postoperative inflammation is alleviated, and recovery time is reduced. Furthermore, shorter hospitalization times reduce hospitalization costs, thereby decreasing the economic burden on patients.

PI and RI are crucial indicators of uterine artery blood flow, and changes in these parameters can reflect the blood supply to endometrial polyps. In addition, there is a close association between ER, PR, and the growth of endometrial polyps. Under pathological conditions, when PR is inhibited, it can interfere with its binding to progesterone. Without this regulatory action, estrogen levels may rise, contributing to endometrial hyperplasia and polyp formation. The results of this study showed that, at 3 months postoperatively, patients who underwent hysteroscopic cold knife resection had lower PI, RI, endometrial thickness, and ER and PR levels compared to the control group. This is primarily due to the fact that hysteroscopic electrosurgery may result in either insufficient or excessive tissue resection, potentially damaging the endometrial tissue. In contrast, hysteroscopic cold knife technology causes less energy-related tissue damage, allowing for precise resection of the polyp tissue without harming surrounding tissues. In agreement with these findings, Jin et al. [20] also reported that hysteroscopic cold knife technology provided superior protection for the endometrium compared to hysteroscopic electrosurgery.

Postoperative recurrence remains a key challenge in the treatment of endometrial polyps, with factors such as incomplete resection and imbalances contributing to recurrence. This study demonstrated a lower recurrence rate in patients treated with the hysteroscopic cold knife technique, indicating that this technique can reduce postoperative recurrence by ensuring more complete removal of polyps. A related clinical study also reported that the 12-month postoperative recurrence rate for patients undergoing hysteroscopic cold knife resection was 3.40%, significantly lower than the 25.17% in patients treated with hysteroscopic electrodesiccation [22]. These findings are consistent with the results of our study.

Additionally, the complication rate was 5.66% in the observation group and 16.98% in the control group; however, the difference was not statistically different. This lack of statistical significance is likely related to the small sample size of the study. Theoretically, hysteroscopic cold knife technology can further reduce the risk of complications while minimizing surgical trauma. To confirm this, future studies with larger sample sizes are planned to ensure the continuity and robustness of the findings.

Despite these positive results, there are some limitations to this study, including the small sample size and the lack of long-term followed up for recurrence. Further in-depth studies with larger sample sizes and extended follow-up periods are needed to address these limitations.

In conclusion, hysteroscopic cold knife technology has demonstrated excellent results in the treatment of endometrial polyps. This procedure is less traumatic, leads to reduced post-operative inflammation, accelerates the recovery, and has a low complication rate. Moreover, it offers protective benefits for the endometrium. Therefore, it is a promising treatment option that warrants broader clinical application.

Disclosure of conflict of interest

None.

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