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Original Article

Correlations between changes in AMH, INHB and sex hormones and pregnancy outcome after laparoscopic surgery for endometriotic cysts

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Abstract: Objective: This study aims to explore the correlation between changes of anti-Mullerian hormone (AMH), human inhibin B (INHB), sex hormones and pregnancy outcomes after laparoscopic surgery for endometriotic cysts. Methods: A total of 40 patients who received laparoscopic surgery for endometriotic cysts from February 2017 to April 2018 were enrolled, and they all underwent the laparoscopic endometriotic cystectomy under the general anesthesia and tracheal intubation. All patients enrolled were followed up by telephone for 1 year. The levels of AMH and INHB, sex hormone-related indexes, antral follicle count (AFC) in the ovulatory period, ovarian stromal arterial pulse index (PI) and resistance index (RI) were measured before operation and at 1 month after operation. The pregnancy outcomes were recorded within 1 year, and the correlations among levels of AMH, INHB, sex hormone-related indexes were analyzed. The influencing factors for the pregnancy after laparoscopic surgery for endometriotic cysts were analyzed. Results: The levels of AMH, INHB estradiol (E_2), follicle-stimulating hormone (FSH) and luteinizing hormone (LH) after operation were significantly higher than those before operation ($P<0.05$). After operation, AFC on the affected side became larger, while the levels of PI and RI were lower than those before operation ($P<0.05$). During the 1-year follow-up, there were 19 cases (47.5%) of natural pregnancy. The levels of AMH and INHB were positively correlated with sex hormone-related indexes E_2, FSH and LH ($P<0.05$). The decreased levels of AMH, INHB, E_2, FSH and LH presented as the independent risk factors for pregnancy after laparoscopic surgery for endometriotic cysts. Conclusion: Laparoscopic endometriotic cystectomy can effectively improve the ovarian function of patients and promote postoperative natural pregnancy, along with increasing levels of AMH, INHB, E_2, FSH and LH.

Keywords: Endometriosis cyst, anti-Mullerian hormone, human inhibin B, sex hormone, pregnancy

Introduction

The most common site of endometriotic cyst occurs within the ovary; which represents a common and frequently-occurring gynecological disease. After treatment, endometriotic cysts can easily relapse. This leads to adhesion and hyperplasia of endometrial fibrous tissues, and affects the reproductive function and ovarian endocrine function [1]. Compared with other reproductive system cysts, endometriotic cysts are generally larger in diameter (around 5 cm), and display a purple-brown color under direct vision. Moreover, due to the reason that the cystic fluids resemble a chocolate-like paste, they are also called ovarian chocolate cysts [2]. The pathogenesis of endometriotic cysts has not been fully clarified [3], and its clinical manifestations primarily include severe symptoms of dysmenorrhea, which can be complicated with follicular dysplasia, resulting in infertility [4].

With the clinical application of laparoscopic techniques, laparoscopic surgery has been adopted in the treatment of ovarian endometriotic cysts, characterized by mild trauma and rapid postoperative recovery [5]. However, there are still risks of dysfunction in the ovarian reserve and even premature ovarian failure after laparoscopic cystectomy, especially for patients with obvious symptoms and severe

pelvic adhesion [6]. In addition, due to incomplete stripping of lesions during operation, postoperative lesion spread and aggravated pelvic adhesion may occur. Basically, conventional laparotomy not only gives rise to trauma and slow postoperative recovery [7], but also poses significant impact on ovarian function. The risk of intestinal adhesion after operation also remains high [8]. Laparoscopic surgery is still recommended as the first choice for surgical treatment of endometriotic cysts [9]. In order to determine the effect of laparoscopic surgery on endometriotic cysts, this study investigated the changes in anti-Mullerian hormone (AMH), human inhibin B (INHB) and sex hormones and compared them before and after operation, as well as analyzing the values for the evaluation of postoperative pregnancy.

Data and methods

General data

A total of 40 patients undergoing laparoscopic surgery for endometriotic cysts in the Affiliated Hospital of Chengde Medical College from February 2017 to April 2018 were selected, all patients were diagnosed with endometriotic cysts in the ovary via routine physical examination before pregnancy. Before enrollment, the patients signed the informed consent, and this study was approved by the Ethics Committee of the Affiliated Hospital of Chengde Medical College. Inclusion criteria: patients were aged 18-35 years, had a desire for pregnancy and an educational level of senior high school and above. Exclusion criteria: patients complicated with mental diseases, with a history of abdominal/pelvic surgery, coagulation disorders, malignant tumors, or dysfunction in the liver, kidney, heart and lung. The average of enrolled patients was 28.2±1.9 years old, including 19 cases of primiparae and 21 cases of multiparae. In terms of the pathogenic site, there were 17 cases with disease on the left side and 23 cases on the right side. The maximum diameter of endometriotic cysts was 2.5-7.5 cm with an average of 4.2±0.6 cm.

Operation methods

All patients received laparoscopic endometriotic cystectomy after general anesthesia and tracheal intubation. After anesthesia induction, a carbon dioxide pneumoperitoneum was established, a sheath clip and laparoscopic lens were placed, the abdominal/pelvic adhesions were bluntly separated, the site of the cyst was determined, and a puncture needle was inserted into the space between the cyst wall and the normal endometrial tissues to inject pituitrin (1:10) (NMPN H32027737, Nanjing Xinbai Pharmaceutical), forming a water-cushion isolation zone between cysts and normal tissues. Then the cortex of cyst was cut off, and the cysts were fully peeled away from the ovary under the tension of the water cushion. For patients with a large diameter of cysts, the cystic fluids were eliminated via vacuum aspiration first, combined with intraoperative hemostasis using bipolar electrocoagulation, and then the cyst incision was sutured and shaped. After that, the pelvic cavity was re-examined, and laparoscopic cystectomy was continued once any other endometriotic cysts were found. After tha operation, a routine drainage tube was placed.

Observation indexes

All patients enrolled were followed up by telephone for 1 year. The levels of AMH and INHB, sex hormone-related indexes, antral follicle count (AFC) in the ovulatory period, ovarian stromal arterial pulse index (PI) and resistance index (RI) were tested and compared before operation and at 1 month after operation, based on the reference value ranges of AMH (2.0-6.8 μg/mL), INHB (≥45 pg/mL), sex hormone-related indexes estradiol (E_2, 370-1850 pmol/L), follicle-stimulating hormone (FSH, 8-20 mIU/mL in ovulatory period) and luteinizing hormone (LH, 75-150 IU/L). The pregnancy outcomes were recorded within 1 year, and the correlations between the levels of AMH and INHB and sex hormone-related indexes were analyzed. Finally, the impact factors for pregnancy after laparoscopic surgery for endometriotic cysts were analyzed. AFC, PI and RI were determined via color Doppler ultrasonography. All patients were followed up for 1 year, and the pregnancy outcomes were recorded, including natural pregnancy and non-pregnancy.

Statistical processing

SPSS 20.0 software was used for statistical processing. Measurement data were expressed as mean ± standard deviation ($\bar{x}$ ± s). *t* test was performed for the comparison of

Table 1. Comparison of AMH and INHB levels before and after operation ($\bar{x} \pm s$)

	AMH (μg/mL)	INHB (pg/mL)
Before operation	1.3±0.2	37.0±1.6
After operation	5.5±0.3	68.7±3.2
t	73.673	56.038
P	0.000	0.000

Table 2. Comparison of sex hormone-related indexes before and after operation ($\bar{x} \pm s$)

	Serum E_2 (pg/mL)	FSH (mIU/mL)	LH (mIU/mL)
Before operation	253.1±33.3	6.3±1.2	63.6±5.2
After operation	461.7±54.3	15.2±2.1	92.1±7.3
t	20.712	23.272	20.111
P	0.000	0.000	0.000

Table 3. Comparison of AFC, PI and RI before and after operation ($\bar{x} \pm s$)

	AFC (n)	RI	PI
Before operation	2.1±0.3	0.61±0.10	0.98±0.15
After operation	6.5±0.9	0.52±0.13	0.89±0.10
t	29.333	3.471	3.157
P	0.000	0.001	0.002

means between the two groups, and χ^2 test for the comparison of rates between the two groups. *P*<0.05 suggested a statistically significant difference.

Results

Comparison of AMH and INHB levels before and after operation

The levels of AMH and INHB after operation were significantly higher than those before operation (*P*<0.05) (**Table 1**).

Comparison of sex hormone-related indexes before and after operation

The levels of E_2, FSH and LH after operation were significantly increased compared to those before operation (*P*<0.05) (**Table 2**).

Comparison of AFC, PI and RI before and after operation

After operation, AFC on the affected side was markedly larger, while the levels of PI and RI were statistically reduced compared with those before operation (*P*<0.05) (**Table 3**).

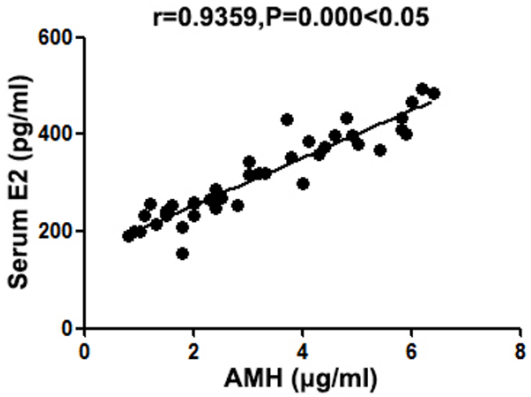

Figure 1. Correlation analysis between AMH level and serum E_2 level.

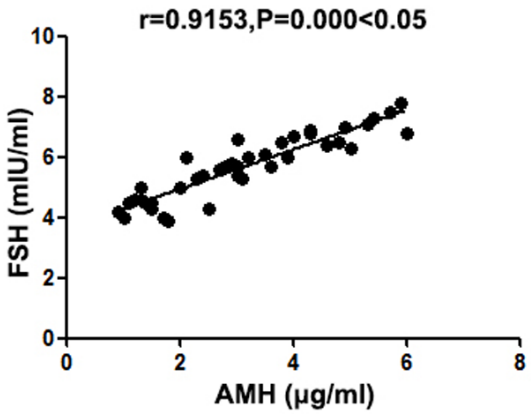

Figure 2. Correlation analysis between AMH level and FSH level.

1-year follow-up

After the 1-year follow-up, there were a total of 19 cases (47.5%) of naturally occuring pregnancy.

Correlation analysis between AMH level and sex hormone-related indexes

The level of AMH was positively correlated with sex hormone-related indexes E_2, FSH and LH (*P*<0.05) (**Figures 1-3**).

Correlation analysis between INHB level and sex hormone-related indexes

The level of INHB was also positively correlated with sex hormone-related indexes E_2, FSH and LH (*P*<0.05) (**Figures 4-6**).

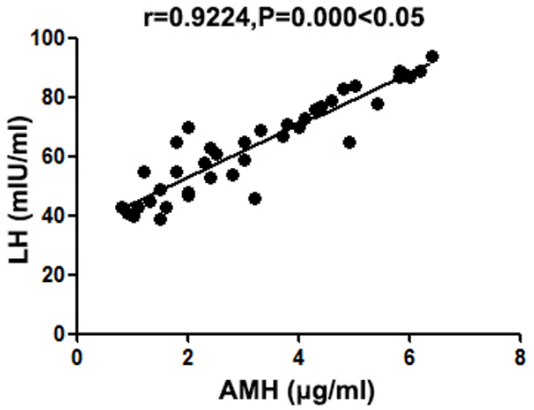

Figure 3. Correlation analysis between AMH level and LH level.

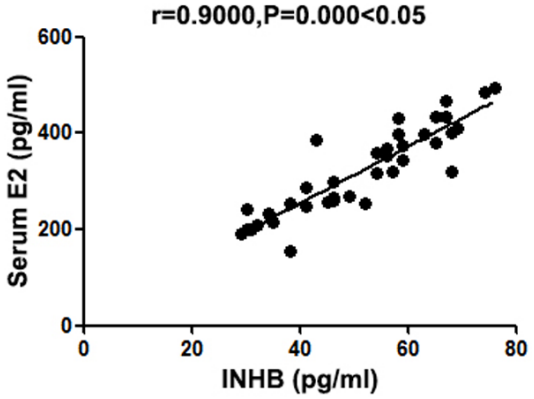

Figure 4. Correlation analysis between INHB level and serum E_2 level.

Analysis of influencing factors for pregnancy after laparoscopic surgery for endometriotic cysts

According to the univariate and Logistic multivariate regression analyses, the decreased levels of AMH, INHB, E_2, FSH and LH served as independent risk factors for pregnancy after laparoscopic surgery for endometriotic cysts (**Tables 4** and **5**).

Discussion

Endometriosis is the most common cause of infertility in women of childbearing age, as well as an estrogen-dependent disease [10]. Research suggests [11] that the morbidity rate of endometriosis in women of childbearing age is up to 10%, which most frequently involves the ovary. After onset, the levels of sex hormones in patients are often changed, leading

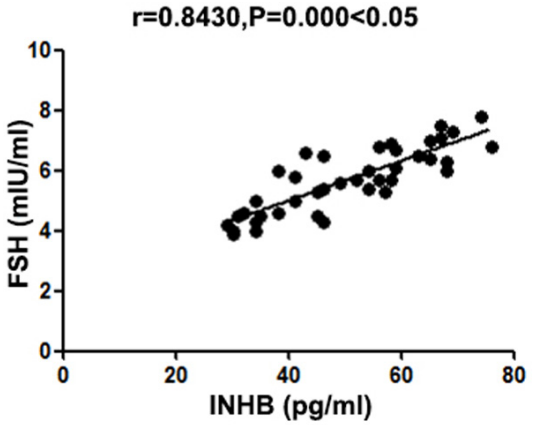

Figure 5. Correlation analysis between INHB level and FSH level.

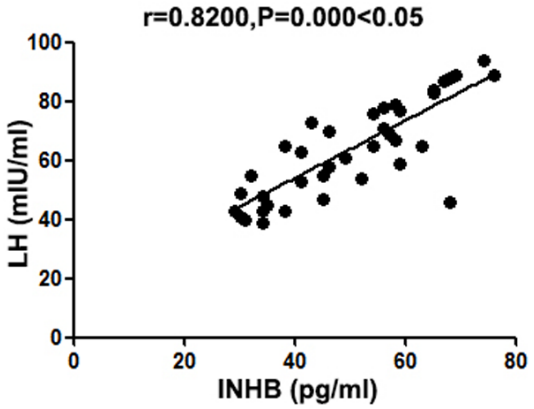

Figure 6. Correlation analysis between INHB level and LH level.

to endometrial tissue fibrosis, cysts or nodules [12]. The diameter of cysts gradually increases with the prolongation of the duration of disease. If cyst rupture occurs, it can cause peritonitis, thus aggravating endometrial tissue fibrosis. At the same time, the cystic fluids present as a chocolate brown color due to repeated bleeding in the cysts [13]. Currently, laparoscopic surgery is the first choice for the treatment of ovarian endometriotic cysts, which, compared with laparotomy, effectively shortens the operation time, reduces the intraoperative bleeding, promotes the postoperative recovery of gastrointestinal function and reduces the hospital stay [14]. Regardless of the operation method, the postoperative recurrence rate of endometriotic cysts remains high. Laparoscopic surgery can better observe the overall conditions of abdominal/pelvic cavity, improve the efficacy of eliminating all lesions

Table 4. Univariate analysis of influencing factors for the pregnancy after laparoscopic surgery for endometriotic cysts

Item		Pregnancy	Non-pregnancy	χ^2	*P*
AMH level	Normal	17	1	25.600	0.0000
	Decline	2	20		
INHB level	Normal	18	2	25.664	0.0000
	Decline	1	19		
E_2 level	Normal	17	3	19.649	0.0000
	Decline	2	18		
FSH level	Normal	16	2	19.565	0.0000
	Decline	3	19		
LH level	Normal	17	1	25.600	0.0000
	Decline	2	20		

Table 5. Logistic multivariate analysis of influencing factors for the pregnancy after laparoscopic surgery for endometriotic cysts

Item	*β*	*SE*	*W*	*OR*	*P*	95% CI
Decreased AMH level	1.049	0.440	5.646	3.853	0.017	1.201-6.773
Decreased INHB level	1.423	0.328	4.663	2.354	0.007	1.803-4.903
Decreased E_2 level	1.328	0.371	3.982	2.281	0.009	1.619-4.624
Decreased FSH level	1.966	0.454	8.781	3.135	0.000	2.933-7.358
Decreased LH level	1.605	0.382	7.717	2.972	0.000	1.354-4.490
Complicated with diabetes	1.587	0.439	5.389	2.887	0.000	1.278-4.782

and reduce the postoperative recurrence rate by comparison [15].

In the present study, all patients underwent laparoscopic surgery. The AMH and INHB levels were measured and compared before and after operation, and it was found that the levels of AMH and INHB after operation were significantly elevated compared to those before operation, indicating that the laparoscopic surgery for patients with endometriotic cysts is of certain value in improving the levels of AMH and INHB after operation. In addition, the comparison of sex hormone-related indexes before and after operation revealed that the levels of E_2, FSH and LH after operation were also markedly higher than those before operation, suggesting that laparoscopic surgery for patients with endometriotic cysts regulates the levels of sex hormones to a certain degree. At the same time, the comparison of AFC, PI and RI before and after operation showed that after operation, AFC on the affected side further enlarged, with rising levels of PI and RI, compared to those before operation, further suggesting that after the laparoscopic surgery, the postoperative recovery of patients with endometriotic cysts is accelerated and the ovulation ability is also greatly restored. Moreover, all patients were followed up for 1 year, and there were 19 cases (47.5%) of natural pregnancy. According to the correlation analysis, the levels of AMH and INHB were positively correlated with E_2, FSH and LH. It was found that the decreased levels of AMH, INHB, E_2, FSH and LH served as independent risk factors for the pregnancy after laparoscopic surgery for endometriotic cysts.

In the treatment of endometriotic cysts, laparoscopic surgery can effectively reduce the loss of functional ovarian tissues and improve the embryo implantation rate during postoperative pregnancy compared with conventional laparotomy, thereby increasing the natural pregnancy rate [16]. At the same time, stripping endometriotic cysts through laparoscopic surgery and washing with a large amount of normal saline during operation can greatly alleviate the pelvic inflammatory state and reduce the local immune status [17], which is conducive to the recovery of follicular function and the regeneration of ovary cortex, and enhances the endometrial receptivity [18]. Additionally, laparoscopic

endometriotic cystectomy is characterized as a sort of simple and quick operation, with the advantages of minimal complications and rapid postoperative recovery. It can effectively reduce surgical trauma, ensure the treatment safety and lower the incidence rate of postoperative pelvic adhesion [19]. Due to the global view of laparoscopic surgery, the distribution of lesions can be observed in detail, and some tiny lesions can be detected easily, so that the effective excision can be achieved [20].

Conclusion

In conclusion, laparoscopic endometriotic cystectomy can effectively improve the ovarian function of patients and promote postoperative natural pregnancy. Postoperative follow-up data indicate that decreased levels of AMH, INHB, E_2, FSH and LH suggest poor prognosis, which requires early intervention to improve the pregnancy rate.

Disclosure of conflict of interest

None.

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