



# Pregnancy outcomes in patients with tubal infertility following laparoscopic treatment: a multivariate predictive study

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**Background:** Tubal infertility represents a large portion of female infertility. This study analyzed the pregnancy outcomes of patients with tubal infertility after laparoscopic treatment. A multivariate predictive analysis was also conducted.

**Methods:** The clinical data of 92 patients admitted in our hospital from March 2015 to March 2018 with tubal infertility were analyzed. According to the inclusion and exclusion criteria, 87 patients were finally included, and all patients were treated with laparoscopy. The clinical data of all study subjects were collected, including age, years of infertility, type of infertility, history of pelvic surgery, history of tubal pregnancy, history of artificial abortion, and lowest tubal function score. The patients were followed up for two years, and multiple logistic regression was used to analyze the factors affecting the pregnancy outcomes of patients with tubal infertility after laparoscopic treatment. The receiver operating characteristic (ROC) curve was used to analyze the predictive values.

**Results:** Among the 87 patients, 63 cases (72.41%) had successful pregnancies at follow-up, and 24 cases (27.58%) were not pregnant. The time of follow up (half a year, 1 year, and 2 years) was not significantly different between the pregnant and the non-pregnant groups. There were no significant differences in the infertility types, pelvic surgery history, and induced abortion history between two groups ( $P>0.05$ ). However, there were differences in the age, years of infertility, tubal pregnancy history, and lowest tubal function score ( $P<0.05$ ). Multivariate analyses showed that the patient's age over 35 years, a lowest tubal function score indicating severe injury, and a history of tubal pregnancy were independent risk factors for the pregnancy outcome of patients with tubal infertility after laparoscopic treatment ( $P<0.05$ ). The area under the ROC curve for age, lowest tubal function score, tubal pregnancy history, and the three combined curves were 0.792, 0.852, 0.816, and 0.949, respectively.

**Conclusions:** The age of the patient, the lowest tubal function score, and the tubal pregnancy history are independent risk factors for the pregnancy outcome of patients with tubal infertility after laparoscopic treatment. Furthermore, the combination of the three risk factors can be used as a predictor of the pregnancy outcome in patients with tubal infertility after laparoscopic treatment.

**Keywords:** Tubal infertility; laparoscopic treatment; pregnancy outcome; multivariate logistic regression analysis

Submitted Nov 11, 2020. Accepted for publication Dec 29, 2020.

doi: 10.21037/apm-20-2347

View this article at: <http://dx.doi.org/10.21037/apm-20-2347>

## Introduction

Tubal infertility accounts for 36% of all female infertilities (1). Blockage or dysfunction of the fallopian tubes is the main cause of tubal infertility, with proximal tubal blockage accounting for about 26% of all infertilities. Blockage is commonly caused by acute or chronic inflammation of the fallopian tubes. The inflammation can infiltrate the inner membrane of the fallopian tube, impairing its function and the ability of the sperm and egg to combine, thereby resulting in infertility (2). In addition, severe inflammation in the fallopian tubes can cause fallopian tube edema and mucosal cell shedding, tubal effusion, and aggravate clinical symptoms and infertility symptoms (3). At present, the clinical treatment of patients with tubal infertility is mainly based on fluid drainage. However, related studies have found limitations to this method as tubal patency is subjectively assessed by the degree of pain felt by the patient. In addition, the rate of tubal patency is nearly always unsatisfactory. Alternatively, laparoscopic treatment may be beneficial as it improves the efficacy of dredging and reduces the occurrence of adverse reactions (4). Therefore, a multivariate predictive study was conducted on patients with tubal infertility who were treated with laparoscopy, and their pregnancy outcomes were analyzed. We present the following article in accordance with the STARD reporting checklist (available at <http://dx.doi.org/10.21037/apm-20-2347>).

## Methods

### *General information*

The clinical data of 92 patients with tubal infertility admitted to our hospital from March 2015 to March 2018 were analyzed. The inclusion criteria were as follows: (I) non-pregnant adult females who had been married for more than one year with a normal sex life and no contraceptive measures; (II) patients who were diagnosed with fallopian tube disease by laboratory and other related tests; (III) patients with no surgical contraindications; and (IV) patients with regular postoperative sexual activity and no contraceptive measures. The exclusion criteria were as follows: (I) infertility caused by other dysfunctions such as male oligospermia and impotence; (II) irregular or infrequent sexual activity; (III) a history of tubal ligation surgery; (IV) patients with immunodeficiencies; and (V) patients who cannot cooperate due to mental disorders; (VI) patients indicated by laparoscopy for female infertility

caused by other reasons. Based on the inclusion and exclusion criteria, a total of 87 patients aged between 24 to 41 years (average  $32.47 \pm 4.29$  years), with an infertility period of 3 to 5 years (average  $3.15 \pm 1.38$  years) were included in this study. This study was approved by the Dazhou Central Hospital (No. 2019029) and was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Individual consent for this retrospective analysis was waived.

### *Surgical methods*

All patients underwent routine checks including blood, leucorrhoea, electrocardiogram, coagulation, and other related indicators before surgery. Sexual activity was prohibited three days prior to surgery.

The laparoscopic instrument used in this study was from Stryker Corporation (State of Michigan, USA). The patients were administered general anesthesia, and placed in the lithotomy position with their heads kept low and the buttocks kept high. The classic three-hole technique was used to enter the abdomen. After entering the abdominal cavity, the pelvic cavity was examined, and the fallopian tube was opened and separated or shaped depending on the specific condition of the fallopian tube. After the surgery, the fallopian tube was treated with fluid drainage, and the degree of obstruction was visualized under the microscope. If the proximal end of both fallopian tubes was completely blocked during the surgery, but the distal end of the fallopian tube was unobstructed with intact tissue structure, the treatment was adjusted to laparotomy for uterine tube implantation.

After the surgery, the patients were followed up for 2 years, through on-site visits, telephone consults, and other methods. The outcomes included normal pregnancy, ectopic pregnancy, and miscarriage.

### *Observation indicators*

General patient information was collected, including age, years of infertility, type of infertility, history of pelvic surgery, history of tubal pregnancy, history of induced abortion, and the lowest tubal function score. The lowest tubal function score was performed by an experienced chief physician in the undergraduate section. The sum of the scores of the bilateral fallopian tubes is used as a measure of the degree of injury, with 7–8 points classified as mild injury, 4–6 points classified as moderate injury, and 0–3

**Table 1** Pregnancy outcomes of tubal infertility patients at half a year, one year, or two years after laparoscopic treatment

Period	Normal pregnancy	Ectopic pregnancy	Not pregnancy
Half a year	19 (21.83)	5 (5.74)	7 (8.04)
1 year	17 (19.54) <sup>a</sup>	4 (4.59) <sup>a</sup>	9 (10.34) <sup>a</sup>
2 years	14 (16.09) <sup>ab</sup>	4 (4.59) <sup>ab</sup>	8 (9.19) <sup>ab</sup>

<sup>a</sup>, P>0.05 was compared with half a year after treatment; <sup>b</sup>, P>0.05 was compared with one year after treatment. The data in brackets were shown as composition ratio.

points classified as severe injury.

### Statistical methods

The data in this study were statistically analyzed using SPSS 22.0 software (IBM, New York, USA). Multiple logistic regression was used to analyze the factors affecting the patient's pregnancy outcome. The measurement data were presented as the mean  $\pm$  standard deviation ( $\bar{x}\pm s$ ), and analyzed using the F/t test. The count data was described as rate or composition ratio and analyzed using the  $\chi^2$  test. The receiver operating characteristic (ROC) curve was drawn to analyze the predictive value of laparoscopic treatment of pregnancy infertility in patients with tubal infertility. Results with P<0.05 were considered statistically significant.

## Results

### *The pregnancy outcome of patients with tubal infertility at half a year, 1 year or 2 years after laparoscopic treatment*

Following laparoscopic treatment on the 87 patients, a total of 63 (72.41%) achieved a normal pregnancy and 24 (27.58%) were not pregnant. However, there was no significant difference between the groups at half a year, 1 year, or 2 years after the surgery (P>0.05, Table 1).

### *Single factor analysis of the pregnancy outcome in patients with tubal infertility after laparoscopic treatment*

The results of single factor analyses demonstrated that there were significant differences in the age, years of infertility, tubal pregnancy history, and lowest tubal function score between the pregnant and the non-pregnant groups (P<0.05). However, no differences were observed in the two groups when comparing infertility, pelvic surgery history, and induced abortion (P>0.05, Table 2).

### *Multivariate analysis of factors affecting pregnancy outcome of patients with tubal infertility after laparoscopic treatment*

The results of multivariate analyses demonstrated that factors such as the patient's age greater than 35 years, a lowest tubal function score showing severe injury, and a history of tubal pregnancy were all independent risk factors for the pregnancy outcome of patients with tubal infertility after laparoscopic treatment (P<0.05, Table 3).

### *The predictive value of pregnancy outcomes in patients with tubal infertility after laparoscopic treatment*

The ROC curve was used to analyze the predictive value of age, the lowest tubal function score, the history of tubal pregnancy, and the combination of the three factors in patients with tubal infertility following laparoscopic treatment. The area under the curve of age, tubal lowest functional score, history of tubal pregnancy, and the combination of the three were 0.792, 0.852, 0.816, 0.949, respectively, indicating that the area under the curve of the combined factors was the largest (Table 4 and Figure 1).

## Discussion

In recent years, with the increased incidences of reproductive tract infections in women of gestational age in China, the prevalence of tubal infertility has also escalated significantly (5). According to epidemiological statistics, tubal infertility is a common type of clinical infertility and accounts for a third of all causes of infertility, and as such, seriously affects the health and quality of life of patients (6). The traditional methods of diagnosis and treatment for infertility are iodine hydrography of uterine salpinx, Chinese and Western medicine treatment and physical therapy. The laparotomy is difficult to be accepted by patients for the large injury after treatment, the unsure

**Table 2** Single factor analyses of the pregnancy outcomes in patients with tubal infertility after laparoscopic treatment

Factor	Pregnancy (n=63)	Infertility (n=24)	$\chi^2$	P
Age (years)			18.202	0.000
≤35	45	5		
>35	18	19		
Infertility time (years)			11.240	0.001
≥3	22	18		
<3	41	6		
Infertility type			0.022	0.881
Primary	33	13		
Secondary	30	11		
Pelvic surgery history			0.004	0.947
Yes	32	12		
No	31	12		
Tubal pregnancy history			19.344	0.000
Yes	15	18		
No	48	6		
Induced abortion history			0.000	0.987
Yes	29	11		
No	34	13		
Lowest tubal function score			23.937	0.000
Mild to moderate injury	49	5		
Severe injury	14	19		

efficacy, and there are false negative hysterosalpingography or asymptomatic patients with subclinical lesions, which is often neglect by the patient or the doctor with the threaten of delay of treatment. Therefore, it is imperative that tubal infertility is treated effectively so as to improve patient pregnancy outcomes (7).

With the development of laparoscopic technology and the improvement of surgical techniques, laparoscopy has become widely used in clinical practice. Laparoscopic surgery is currently the preferred method of clinical treatment in tubal infertility patients (8). Laparoscopy allows for the clear visualization of the obstruction and stenosis of the fallopian tubes, effective observation of the pelvic condition, correct evaluation of the shape and function of the fallopian tube, and direct visualization of the relationship between the fallopian tube and the surrounding tissues. Therefore, it allows the clinician to clearly diagnose pelvic diseases and assess the status of the fallopian tubes for particular treatment. Laparoscopic treatment has been shown to be the most effective method of restoring the natural physiological state and function of the fallopian tubes (9). Laparoscopy has the advantages of less trauma, faster recovery, and reduced postoperative complications (10). Relevant studies have shown that laparoscopy can comprehensively assess the functional status of the patient's fallopian tubes and deliver targeted treatment, which is beneficial to increasing pregnancy rates and improving pregnancy outcomes (11). Wang (12) studied 181 patients with tubal infertility and showed that the normal pregnancy rate was as high as 61.33% at three years after laparoscopic surgery of the fallopian

**Table 3** Multivariate analyses of the factors influencing pregnancy outcome after laparoscopic treatment of tubal infertility

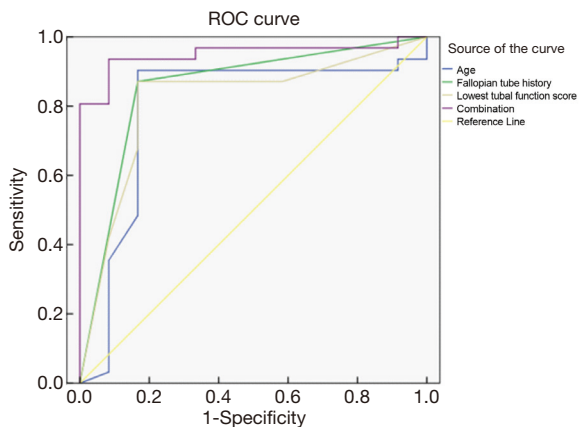
Factor	Regression coefficient	SEM	Wald $\chi^2$	P	OR (95% CI)
Infertility time (>3 vs. ≤3 years)	0.794	0.895	4.596	0.292	2.21 (0.38–12.78)
Age (>35 vs. ≤35 years)	0.869	0.161	4.596	<0.001	2.38 (1.74–3.26)
Lowest tubal function score (mild to moderate injury vs. severe injury)	0.893	0.325	4.523	<0.001	2.44 (1.29–4.62)
Tubal pregnancy history (yes vs. no)	0.763	0.134	4.694	<0.001	2.14 (1.65–2.79)

SEM, standard error of mean; OR, odd ratio; CI, confidence interval.

**Table 4** Predictive value of factors on the pregnancy outcome after laparoscopic treatment in patients with tubal infertility

Predictive factor	Optimal threshold	Sensitivity	Specificity	AUC of ROC	95% CI
Age	25.64	0.742	0.763	0.792	0.614–0.969
Tubal pregnancy history	34.42	0.765	0.754	0.852	0.711–0.993
Lowest tubal function score	36.41	0.759	0.748	0.816	0.666–0.966
Triadic combined test	37.45	0.864	0.886	0.949	0.000–1.000
Predictive exponential model	1.687	0.354	0.789	0.768	0.754–0.865

AUC, area under the curve; ROC, receiver operating characteristic curve; CI, confidence interval.

**Figure 1** The predictive value of factors on the pregnancy outcome after laparoscopic treatment in patients with tubal infertility.

tubes. In this current study, the pregnancy rate of patients with tubal infertility after laparoscopic treatment was 72.41%, indicating that the clinical efficacy of laparoscopic treatment in patients with tubal infertility was sufficient to achieve an ideal postoperative pregnancy rate. These results support that notion that laparoscopic surgery is a beneficial clinical treatment for patients with tubal infertility (13).

To verify the impact of laparoscopic treatment on tubal infertility patients, this study conducted a 2-year follow-up for the 87 patients. The results demonstrated that during the follow-up period, 24 patients did not fall pregnant, and the infertility rate was 27.58%. Previous research has shown that the clinical efficacy of laparoscopic treatment on tubal infertility is directly related to the patient's age, tubal function score, history of miscarriage, and other factors (14). Related studies have also found that for patients with tubal infertility treated with laparoscopic methods, tubal function scores, pelvic and tubal lesion locations and degrees, and years of infertility are risk factors for poor pregnancy (15,16).

In agreement with the above reports, this study revealed that the patient's age greater than 35 years, a lowest tubal function score indicating severe injury, and a history of tubal pregnancy were independent risk factors for poor pregnancy outcomes in patients with tubal infertility after laparoscopic treatment ( $P < 0.05$ ). This study further used the ROC curves to analyze the predictive value of age, the lowest tubal function score, the tubal pregnancy history, and the combination of the three factors in the prognosis of patients with tubal infertility after laparoscopic treatment. The results showed that the combination of the three factors had the largest area under the curve, and hence, the combined test achieved the highest predictive value. Therefore, the combined evaluation of the three factors can be used in the prediction of pregnancy outcomes for patients with tubal infertility after laparoscopic treatment.

Therefore, for patients over 35 years of age, active intervention measures should be considered based on the specific condition of the patient, and surgical intervention should be carried out as soon as possible to improve the therapeutic benefits. A large number of clinical manifestations have shown that for patients with a history of tubal pregnancy and a lowest tubal function score indicating severe injury, the postoperative pregnancy rate is decreased (17). In fact, the lowest tubal function score system is often used as a reference for gynecologists to predict postoperative pregnancy rates. The lower the score, the lower the postoperative pregnancy rate (18). Therefore, depending on comprehensive factors such as the actual situation of the patient and the patient's economic status, *in vitro* fertilization embryo transfer and other intervention-assisted reproduction treatments may be considered to improve the pregnancy rate of these patients, so as not to miss the best time for treatment of patients (19). Due to the small sample size of this study, the bias of the experimental results was inevitable. Therefore, the sample size should



be expanded in further research to obtain more accurate experimental results.

In summary, the patient's age, the lowest tubal function score, and the tubal pregnancy history are independent risk factors for the pregnancy outcome of patients with tubal infertility after laparoscopic treatment. The combination of these three risk factors can be used as a predictive index to evaluate the outcome of pregnancy in such patients.

## Acknowledgments

*Funding:* None.

## Footnote

*Reporting Checklist:* The authors have completed the STARD reporting checklist. Available at <http://dx.doi.org/10.21037/apm-20-2347>

*Data Sharing Statement:* Available at <http://dx.doi.org/10.21037/apm-20-2347>

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/apm-20-2347>). The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study was approved by the Dazhou Central Hospital (No. 2019029) and was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Individual consent for this retrospective analysis was waived.

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- (English Language Editor: J. Teoh)

**Cite this article as:** Zhang L, Jiang F, Qi R, Fu W, Wang Y, Gui D. Pregnancy outcomes in patients with tubal infertility following laparoscopic treatment: a multivariate predictive study. *Ann Palliat Med* 2021;10(1):462-468. doi: 10.21037/apm-20-2347