Association between serum hCG level and persistent trophoblasts after laparoscopic surgery for tubal ectopic pregnancy: A retrospective study.

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Research Article

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Abstract

Background: Laparoscopic salpingostomy to treat tubal ectopic pregnancy (TEP) is increasing due to patient preference for subsequent spontaneous pregnancy. However, the incidence of persistent trophoblasts (PT) ranges from 5–29%, though PT rarely occurs after laparoscopic salpingectomy. For this reason, the selection of laparoscopic salpingostomy should be performed carefully. Here, we aimed to identify the risk factors for PT, focusing on serum hCG levels.

Methods: We reviewed the medical records of 128 patients who underwent laparoscopic surgeries for TEP from 2015/1/1 to 2021/12/31, including 62 with laparoscopic salpingostomy and 66 with laparoscopic salpingectomy. Among these cases, we identified 13 with PT detected during the postoperative follow-up period. We performed a multivariate logistic regression analysis to assess the influence of each representative factor, especially serum hCG levels, on the occurrence of PT. We first performed this analysis for 62 cases with laparoscopic salpingostomy and then for all 128 cases. Additionally, we focused on the reduction rates of serum hCG levels after surgery. Based on the scatter plot of the association between the reduction rates and elapsed time after surgery, we tried to create linear regression lines for estimating the appropriate postoperative follow-up period.

Results: In the multivariate analyses of the 62 cases with laparoscopic salpingostomy, “high hCG”, including serum hCG levels of over 2000 and 4000 mIU/mL, showed significance. These results were also detected in the analysis of all 128 cases. Next, we obtained the regression lines based on the scatter plots of the association between reduction rates of serum hCG levels and elapsed time after surgery. By referring to the slopes of the regression lines, we could predict 37 and 30 days as necessary for serum hCG levels to be reduced to one-thousandth in the cases with laparoscopic salpingostomy and salpingectomy.

Conclusions: Our evaluation of the association between serum hCG level and PT allows us to provide the selection criteria, namely, serum hCG level over 2000 and 4000 mIU/mL, for laparoscopic salpingostomy. Additionally, our analysis of the association between the reduction rates of serum hCG levels and the elapsed time after surgery allows us to predict the appropriate length for the postoperative follow-up period.

Background

The incidence of tubal ectopic pregnancy (TEP) is approximately 2% [1,2]. In addition to other fallopian tube-related factors, infertility treatment can increase the risk of TEP [3], and the possibility of encountering TEP in the clinic has been increasing. Recently, laparoscopic surgery, mainly including salpingectomy and salpingostomy, has become the gold standard treatment for TEP due to its cost-effectiveness [4]. The choice between these two methods for primary TEP tends to be determined on the basis of both the findings obtained during surgery, such as tubal damage, and the patient’s situation, including her parity and future fertility expectations [5]. Some reports have recommended laparoscopic salpingostomy for

patients who are unwilling to consider assisted reproductive technology (ART) [5], and recently, the use of laparoscopic salpingostomy has shown an increasing trend. The early and accurate diagnosis of TEP before tubal rupture with the combination of imaging by transvaginal ultrasound (TVUS) and the measurement of serum human chorionic gonadotropin (hCG) levels [4] has also contributed to this trend. However, other reports have concluded that post-surgical fertility is not different when cases of ART are included [6,7]. The incidence of persistent trophoblasts (PT) after laparoscopic salpingostomy is thought to be approximately 5–29% [8–11], and the risk of recurrent ectopic pregnancy (REP) rises [12]. Among these two problems, PT is treated as a surgical failure because PT is usually detected within one month after the operation [11] and needs long-term treatment periods. Additionally, according to some reports, the decline in serum hCG levels is slower in patients with PT [9], but the relationship between serum hCG levels and the risk of PT has not been elucidated. Therefore, in this study, after comparing the clinical outcomes of these two operation methods, we aimed to identify the risk factors for PT to provide criteria for selecting laparoscopic salpingostomy or salpingectomy. In particular, because serum hCG levels have been examined many times for both diagnosis and postoperative follow-up in our hospital, we focused mainly on the association between PT and serum hCG levels.

Methods

Data collection

This study was reviewed and approved by the Human Ethical Committee of the University of Teikyo Hospital (Trial registration number: 20–094). The deidentified medical records of 150 female patients who underwent laparoscopic surgeries, performed after obtaining informed consent, from June 1, 2015, to December 31, 2021, were reviewed retrospectively, and the 22 cases were excluded for the following reasons: peritoneal ectopic pregnancy (9 cases), miscarriage from fallopian tube (8 cases), no detection of pregnancy tissue (3 cases), ovarian ectopic pregnancy (1 case) and uterine horn pregnancy (1 case). We extracted data on representative patient characteristics, such as age, delivery history, presenting symptoms, and physical data, from medical records. In particular, in all patients, serum hCG levels were examined several times, including before and after surgery, and we extracted these data. To evaluate the failure rates of laparoscopic surgeries, we extracted the data on PT (13 cases), in which patients were diagnosed per rising or plateauing serum hCG levels postoperatively and needed to be treated by intramuscular methotrexate injection (IMI).

Analysis methods

First, to compare the rates of PT between laparoscopic salpingostomy and salpingectomy, we divided the patients into two groups according to these treatment methods. In our hospital, the choice between these two methods depended largely on the patient’s situation, and the numbers were approximately equal. In only 6 cases, tubal pregnancy rupture was detected during surgery. In these two groups, we compared the 19 indexes shown in Table 1 by using Student's t-test, Pearson's chi-square test and the Mann–Whitney U test. By referring to a previous study evaluating the influence of the ratio of serum hCG levels before and

after laparoscopic salpingostomy on the possibility of PT [9], we also compared this index ("hCG ratio" in Table 1). Second, we tried to evaluate the risk factors for PT, especially to detect the predictive values of preoperative serum hCG levels. Then, four approximate cut-offs values were used for serum hCG levels: 2000, 4000, 6000 and 8000 mIU/mL. For each of these four parameters, we performed similar analyses. We first analysed the 62 patients who underwent laparoscopic salpingostomy and then analysed all 128 patients. To control for confounding factors, we divided the patients into two groups according to the presence or absence of each factor and performed multivariate logistic regression analysis. In this analysis, we assessed the influence of the following 14 factors: 1) Advanced age, defined as an age ≥ 38 years; 2) High body mass index (BMI), defined as a BMI ≥ 25 (kg/m^2); 3) Nulliparity, defined as no previous delivery; 4) Embryo transfer, defined as cases in which the patients became pregnant after embryo transfer; 5) Abnormal bleeding, defined as patients with abnormal vaginal bleeding caused by TEP; 6) Abdominal pain, defined as patients with abdominal pain caused by TEP; 7): Pelvic haematoma, defined as cases in which pelvic haematoma was detected by TVUS before surgery or during surgery; 8) Foetal heartbeat, defined as cases in which foetal heartbeat was detected by TVUS; 9) Isthmic tubal pregnancy, defined as cases in which isthmic tubal pregnancy was diagnosed during surgery; 10) Abdominal adhesion, defined as abdominal adhesion detected by laparoscopic inspection immediately after the start of surgery; 11) Salpingostomy; 12) High hCG, defined as a serum hCG level ≥ 2000, 4000, 6000, or 8000 mIU/mL; 13) Coexistent leiomyoma, defined as leiomyoma detected by laparoscopic inspection; and 14) Coexistent endometriosis, defined as endometriosis detected by laparoscopic inspection. Since the average age of the patients was 33.4 ± 4.8 years and since over 40% of the included patients became pregnant after infertility treatments, "Advanced age" was defined as patients aged 38 years or older with reference to a previous report [13]. Statistical analyses were performed using Microsoft Excel (Microsoft Corporation, Redmond, WA) and JMP version 12 for Windows (SAS Institute, Inc., Tokyo, Japan) to determine the correlations between patient characteristics and the failure of laparoscopic surgery. The odds ratios (ORs) and 95% confidence intervals (CIs) were estimated to determine the strengths of the correlations. $P < 0.05$ was considered statistically significant.

Table 1
Comparison of patient characteristics between laparoscopic salpingostomy and salpingectomy.

	Total	Salpingostomy (n = 62)	Salpingectomy (n = 66)	P value
Age	33.4 ± 4.8 (20–44, n = 128)	32.0 ± 4.5 (20–43, n = 62)	34.8 ± 4.7 (22–44, n = 66)	< 0.01
BMI	21.3 ± 2.8 (17.1–29.9, n = 128)	21.3 ± 2.9 (17.2–29.9, n = 62)	21.3 ± 2.7 (17.1–28.4, n = 66)	NS
Blood loss	126.4 ± 237.5 (0-1334, n = 128)	104.5 ± 229.3 (0-1334, n = 62)	147.0 ± 245.0 (0-1200, n = 66)	NS
Operation time	54.1 ± 20.1 (25–144, n = 128)	48.6 ± 12.3 (31–100, n = 62)	59.3 ± 24.2 (25–144, n = 66)	< 0.01
Treatment period	32.4 ± 17.9 (9-110, n = 128)	37.2 ± 22.4 (9-110, n = 62)	27.8 ± 10.3 (10–66, n = 66)	< 0.01
Average hCG	6528.1 ± 11513.8 (2.9-91673.2, n = 128)	3477.4 ± 3493.0 (2.9-18550.1, n = 62)	9393.8 ± 15177.3 (126.2-91673.2, n = 66)	< 0.01
Median hCG	2879.5	2117	4093.4	< 0.05
hCG ratio	0.38 ± 0.16 (0.10–1.18, n = 121)	0.41 ± 0.18 (0.11–1.18, n = 59)	0.35 ± 0.13 (0.10–0.94, n = 62)	NS
Embryo transfer	23.4% (n = 30/128)	3.2% (n = 2/62)	42.4% (n = 28/66)	< 0.01
Nulliparity	72.7% (n = 93/128)	79.0% (n = 49/62)	66.7% (n = 44/66)	NS
Abnormal bleeding	49.2% (n = 63/128)	56.5% (n = 35/62)	42.4% (n = 28/66)	NS
Abdominal pain	36.7% (n = 47/128)	37.1% (n = 23/62)	36.4% (n = 24/66)	NS
Pelvic haematoma	46.9% (n = 60/128)	48.4% (n = 30/62)	45.5% (n = 30/66)	NS
Foetal heartbeat	14.1% (n = 18/128)	8.1% (n = 5/62)	19.7% (n = 13/66)	NS
Isthmic tubal pregnancy	18.8% (n = 24/128)	12.9% (n = 8/62)	24.2% (n = 16/66)	NS
Abdominal adhesion	35.2% (n = 45/128)	32.3% (n = 20/62)	37.9% (n = 25/66)	NS
Persistent trophoblast	10.2% (n = 13/128)	19.4% (n = 12/62)	1.5% (n = 1/66)	< 0.01
Coexistent leiomyoma	14.8% (n = 19/128)	6.5% (n = 4/62)	22.7% (n = 15/66)	< 0.01

	Total	Salpingostomy (n = 62)	Salpingectomy (n = 66)	P value
Coexistent endometriosis	7.0% (n = 9/128)	8.1% (n = 5/62)	6.1% (n = 4/66)	NS

After dividing 128 patients into two groups according to laparoscopic surgical methods, we compared 19 representative indexes. In this analysis, eight indexes, namely, “age”, “operation time”, “treatment period”, “average hCG”, “median hCG”, “embryo transfer”, “persistent trophoblast” and “coexistent leiomyoma”, showed significant differences.

Abbreviations: BMI: body mass index, NS: no significance, hCG: human chorionic gonadotropin.

Serum hCG level reduction rate

To estimate the appropriate postoperative follow-up period, we created linear regression lines based on the scatter plot of the association between reduction rates of serum hCG levels and elapsed time after surgery (laparoscopic salpingostomy: n = 236, laparoscopic salpingectomy: n = 289) by using the ordinary least-squares method with Microsoft Excel. In this analysis, 13 cases with PT were excluded. These plots did not include data below the detection sensitivity (laparoscopic salpingostomy: n = 7, laparoscopic salpingectomy: n = 4). We calculated the indexes in as follows: 1) we divided the serum hCG levels postoperatively by these levels immediately before the operation and 2) calculated the Log_{10} values. The formula used was Log_{10} (serum hCG level after/before operation (mIU/mL)). The relationship between this logarithmic index and elapsed time after surgery (days) was plotted. Then, by referring to the slopes of these regression lines, we estimated each required follow-up period for patients with laparoscopic salpingostomy or salpingectomy.

Results

Patient characteristics

The average age, BMI, operation time, blood loss volume and treatment period of the included patients were 33.4 ± 4.8 (20–44) years, 21.3 ± 2.8 (17.1–29.9) kg/m^2, 54.1 ± 20.1 (25–144) min, 126.4 ± 237.5 (0–1334) ml and 32.4 ± 17.9 (9–110) days, respectively. The average and median serum hCG levels just before surgery were 6528.1 ± 11513.8 (2.9–91673.2) and 2879.5 mIU/mL, respectively. The average ratio of serum hCG levels before and after surgery was 0.38 ± 0.16 (0.10–1.18). When the characteristics of patients with laparoscopic salpingostomy and salpingectomy were compared, significant differences in patient age, operation time, treatment period, the number of patients with embryo transfer, PT and coexistent leiomyoma were detected (Table 1). In the analysis of serum hCG levels, we detected a trend wherein laparoscopic salpingectomy was chosen to treat patients with high serum hCG levels, and the average and median hCG levels were higher in patients with laparoscopic salpingectomy than in those with salpingostomy (9393.8 ± 15177.3 vs. 3477.4 ± 3493.0 and 4093.4 vs. 2117.0 mIU/mL). Although laparoscopic salpingostomy tended to be performed for patients with relatively low serum hCG levels, 12

out of the 13 cases with PT were detected among the 62 cases with laparoscopic salpingostomy. Among these 12 cases, PT was detected approximately two weeks after surgery (15.0 ± 8.8, 3–36 days) by the rebound of decreased serum hCG levels (1304.6 ± 1177.5, 101.2–3465.3 mIU/mL). In 11 out of 12 cases, we performed IMI once, but in one case, we needed to perform IMI twice. Among patients undergoing laparoscopic salpingectomy, only one was diagnosed with PT and needed IMI 4 days after surgery (serum hCG levels: 456.6 mIU/mL). Next, we compared the serum hCG levels of these 12 PT cases with those of the 50 cases with successive laparoscopic salpingostomy. The average serum hCG level tended to be high among the 12 cases with PT (4635.4 ± 2401.1 vs. 3199.5 ± 3672.6 mIU/mL, $p = 0.20$), and the median was more than twice that of the non-PT cases (4627.6 vs. 1899.1 mIU/mL, $p < 0.05$). On the other hand, the ratios of the serum hCG levels before and after laparoscopic salpingostomy were similar (0.45 ± 0.23 vs. 0.40 ± 0.17, $p = 0.43$).

Preparation of reference criteria for serum hCG levels for laparoscopic salpingostomy

To evaluate the association between PT and serum hCG levels, we referred to the aforementioned difference in serum hCG levels between successful and failed cases after laparoscopic salpingostomy. Concretely, we set the cut-off values based on serum hCG levels of 2000, 4000, 6000 and 8000 mIU/mL and performed a multivariate analysis that included an additional 13 factors. First, in this analysis of 62 cases with laparoscopic salpingostomy (Table 2), “high hCG”, including serum hCG levels of 2000 and 4000 mIU/mL, showed a significant difference (OR = 14.0, $p < 0.01$ and OR = 6.3, $p < 0.01$), but significance was not apparent for other factors. When focusing on patients whose serum hCG levels were lower than 2000 mIU/mL, we detected few cases with PT after laparoscopic salpingostomy (OR = 0.071, 95% CI: 0.0086–0.60, n = 1/29). Second, as expected, the analysis of all 128 cases showed the following significant factors: “hCG ≥ 2000” (OR = 8.6, $p < 0.01$), “hCG ≥ 4000” (OR = 3.5, $p < 0.01$) and “Salpingostomy” (OR = 15.6, $p < 0.01$) (Table 3). In both analyses, two values for serum hCG levels, 2000 and 4000 mIU/mL, were considered to be important. However, other significant predictors could not be detected. From these results, we can provide the following three classifications: 1) for patients whose serum hCG levels are under 2000 mIU/mL, we can safely perform laparoscopic salpingostomy; 2) for patients whose serum hCG levels are over 4000 mIU/mL, we should select laparoscopic salpingectomy to avoid PT; and 3) for patients whose serum hCG levels are between 2000 and 4000 mIU/mL, we should determine the method while considering other patient factors.

Table 2
Identification of influencing factors for persistent trophoblasts after laparoscopic salpingostomy.

	Number	OR (95% CI, number)	P value
Advanced age	5	1.1 (0.1–10.3, n = 1/5)	NS
High BMI	7	0.7 (0.1–6.1, n = 1/7)	NS
Nulliparity	49	0.8 (0.2–3.3, n = 9/49)	NS
Embryo transfer	2	4.5 (0.3–76.9, n = 1/2)	NS
Abnormal bleeding	35	1.1 (0.3–3.9, n = 7/35)	NS
Abdominal pain	23	1.3 (0.4–4.6, n = 5/23)	NS
Pelvic haematoma	30	1.0 (0.3–3.8, n = 6/30)	NS
Foetal heartbeat	5	1.1 (0.1–10.3, n = 1/5)	NS
Isthmic tubal pregnancy	8	0.6 (0.1-5.0, n = 1/8)	NS
Abdominal adhesion	20	1.7 (0.5–6.1, n = 5/20)	NS
High hCG			
hCG > 2000	33	14.0 (1.7-116.9, n = 11/33)	< 0.01
hCG > 4000	20	6.3 (1.6–24.8, n = 8/20)	< 0.01
hCG > 6000	11	1.8 (0.4–7.9, n = 3/11)	NS
hCG > 8000	4	1.4 (0.1–15.0, n = 1/4)	NS
Coexistent leiomyoma	4	1.4 (0.1–15.1, n = 1/4)	NS
Coexistent endometriosis	5	3.1 (0.5–21.3, n = 2/5)	NS

A multivariate analysis of 62 patients was performed to examine the influence of 13 representative factors that were collected from medical records. The number of patients with each factor, the ORs and 95% CIs for the occurrence of persistent trophoblasts and the P values are shown in this table. Only “high hCG” was identified as a significant factor for the occurrence of these complications when the borderline was set to 2000 or 4000 mIU/mL.

Abbreviations: OR: Odds ratio, CI: Confidence interval, NS: No significance, BMI: Body mass index, hCG: human chorionic gonadotropin.

Table 3
Identification of influencing factors for persistent trophoblasts.

	Number	OR (95% CI, number)	P value
Advanced age	26	0.3 (0.04–2.4, n = 1/26)	NS
High BMI	15	0.6 (0.1-5.0, n = 1/15)	NS
Nulliparity	93	1.3 (0.3-5.0, n = 10/95)	NS
Embryo transfer	30	0.6 (0.1–2.7, n = 2/30)	NS
Abnormal bleeding	63	1.8 (0.5–5.7, n = 8/63)	NS
Abdominal pain	47	1.6 (0.5–4.9, n = 6/47)	NS
Pelvic haematoma	60	1.0 (0.3–3.1, n = 6/60)	NS
Foetal heartbeat	18	0.5 (0.1–3.9, n = 1/18)	NS
Isthmic tubal pregnancy	24	0.3 (0.04–2.7, n = 1/24)	NS
Abdominal adhesion	45	1.2 (0.4–3.8, n = 5/45)	NS
Salpingostomy	62	15.6 (2.0-124.0, n = 12/62)	< 0.01
High hCG			
hCG > 2000	79	8.6 (1.1–68.4, n = 12/79)	< 0.01
hCG > 4000	54	3.5 (1.0-12.1, n = 9/54)	< 0.01
hCG > 6000	35	0.8 (0.2-3.0, n = 3/35)	NS
hCG > 8000	22	0.4 (0.1-3.0, n = 1/22)	NS
Coexistent leiomyoma	19	0.5 (0.1–3.7, n = 1/19)	NS
Coexistent endometriosis	9	2.8 (0.5–15.2, n = 2/9)	NS

A multivariate analysis of 128 patients was performed to examine the influence of 14 representative factors that were collected from medical records. The number of patients with each factor, the ORs and 95% CIs for the occurrence of persistent trophoblasts and the P values are shown in this table. “Salpingostomy” and “high hCG” were identified as significant factors for the occurrence of these complications.

Abbreviations: OR: Odds ratio, CI: Confidence interval, NS: No significance, BMI: Body mass index, hCG: human chorionic gonadotropin.

Rate of decrease in serum hCG levels after laparoscopic surgery

To estimate the required follow-up period after laparoscopic salpingostomy and salpingectomy, we calculated the rate of decrease in the serum hCG levels by using the logarithmic index (Fig. 1). In this

analysis, the slopes of the regression lines in cases with laparoscopic salpingostomy and salpingectomy were − 0.092 and − 0.11 (R^2 = 0.74 and 0.87), respectively. By using these results, to pursue the decline in serum hCG levels until reaching approximately one-thousandth to one ten-thousandth, we needed follow-up periods of 27 to 36 days after laparoscopic salpingectomy and 33 to 43 days after laparoscopic salpingostomy.

Discussion

In total, we detected PT in 13 out of 128 cases approximately two weeks after laparoscopic surgeries and needed to treat with IMI. Among these 13 cases, patients needed a postoperative follow-up period that was more than twice as long as that of the other 115 successive cases (62.8 ± 29.0 vs. 26.8 ± 12.8 days). Only one case with PT was detected after laparoscopic salpingectomy, but 12 out of 62 cases had PT after laparoscopic salpingostomy. This result was roughly similar to that of previous reports, in which researchers reported that the occurrence of PT after laparoscopic salpingostomy ranged from 5 to 29% [8–11]. Next, we analysed 17 representative factors for predicting the occurrence of PT (Table 1). In this analysis, we found that “high hCG”, defined as an hCG level above 2000 or 4000 mIU/mL, showed a significant influence on the increase in the possibility of PT. These classifications were almost consistent with those defined in previous reports, namely, an hCG level above 2500, 3000, or 5000 mIU/mL [11,14,15]. From these results, we can simply provide the following criteria on the selection of surgical methods: 1) when the serum hCG level is < 2000 mIU/mL, we can positively select laparoscopic salpingostomy, but 2) when the serum hCG level is ≥ 4000 mIU/mL, we cannot strongly recommend laparoscopic salpingostomy. For patients whose serum hCG levels were between 2000 and 4000 mIU/mL, it was difficult to form a definite conclusion. Since some reports pointed out the higher possibility of subsequent intrauterine pregnancy after laparoscopic salpingostomy [5,6], early diagnosis of TEP before reaching relatively high serum hCG levels may become increasingly important. On the other hand, we did not find other significant factors, probably because our sample size was relatively small compared with those of previous reports [6,7,9–11]. And another clear limitation was detected compared with these previous reports [14,15]. We could not collect the data on ectopic pregnancy size, since in 36 out of 128 cases, this size could not be measured due to a surrounding haematoma.

In this study, we also evaluated the speed of postoperative declines in serum hCG levels after laparoscopic salpingostomy and salpingectomy by plotting the association between the decreasing rate and period (Fig. 1). As expected, according to these linear regression lines, a longer follow-up period was needed after laparoscopic salpingostomy. Considering the average and median serum hCG levels of patients with laparoscopic salpingostomy (3477.4 ± 3493.0 and 2117.0 mIU/mL, Table 1), these patients may need an approximately one-week extra follow-up period to confirm negative serum hCG levels. Due to these difficulties of postoperative management, including the relatively high risk of PT and long follow-up period, the adoption of laparoscopic salpingostomy should be determined carefully.

Conclusion

For patients whose serum hCG levels are relatively low, such as below 2000 mIU/mL, we can positively select laparoscopic salpingostomy, but we should select this method carefully for other patients whose serum hCG levels are over 4000 mIU/mL, due to the higher risk of PT. And this method may demand us to prepare an approximately one-week extra follow-up period.

Abbreviations

ART: assisted reproductive technology, BMI: body mass index, CI: confidence interval, hCG: human chorionic gonadotropin, IMI: intramuscular methotrexate injection, OR: odds ratio, PT: persistent trophoblasts, REP: recurrent ectopic pregnancy, TEP: tubal ectopic pregnancy, TVUS: transvaginal ultrasound.

Declarations

Ethics approval and consent to participate

This retrospective study was approved by the Institutional Review Board of Teikyo University. The study registry number, registry name and registration date are as follows: 20-094, Clinical outcomes and complications of laparoscopic surgeries for gynaecological tumours: retrospective analyses, 2020/7/17.

Consent for publication

Written informed consent was obtained from all patients for the publication of all data. The retrospective analysis of 128 patients was approved by the Human Ethical Committee of the University of Teikyo Hospital (Trial registration number: 20-094). A copy of the written consent form is available for review by the Editor-in-Chief of this journal.

Availability of data and materials

The authors agree to make all data in this study freely available.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

MH and WI collected and analysed the data and wrote the manuscript. AT and ON supervised the whole study. MH, AT, AO, MH, AS, RM and HT performed all operations. AF and ON determined the methods of all operations and supervised all medical procedures. All authors read and approved the final manuscript.

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Figures

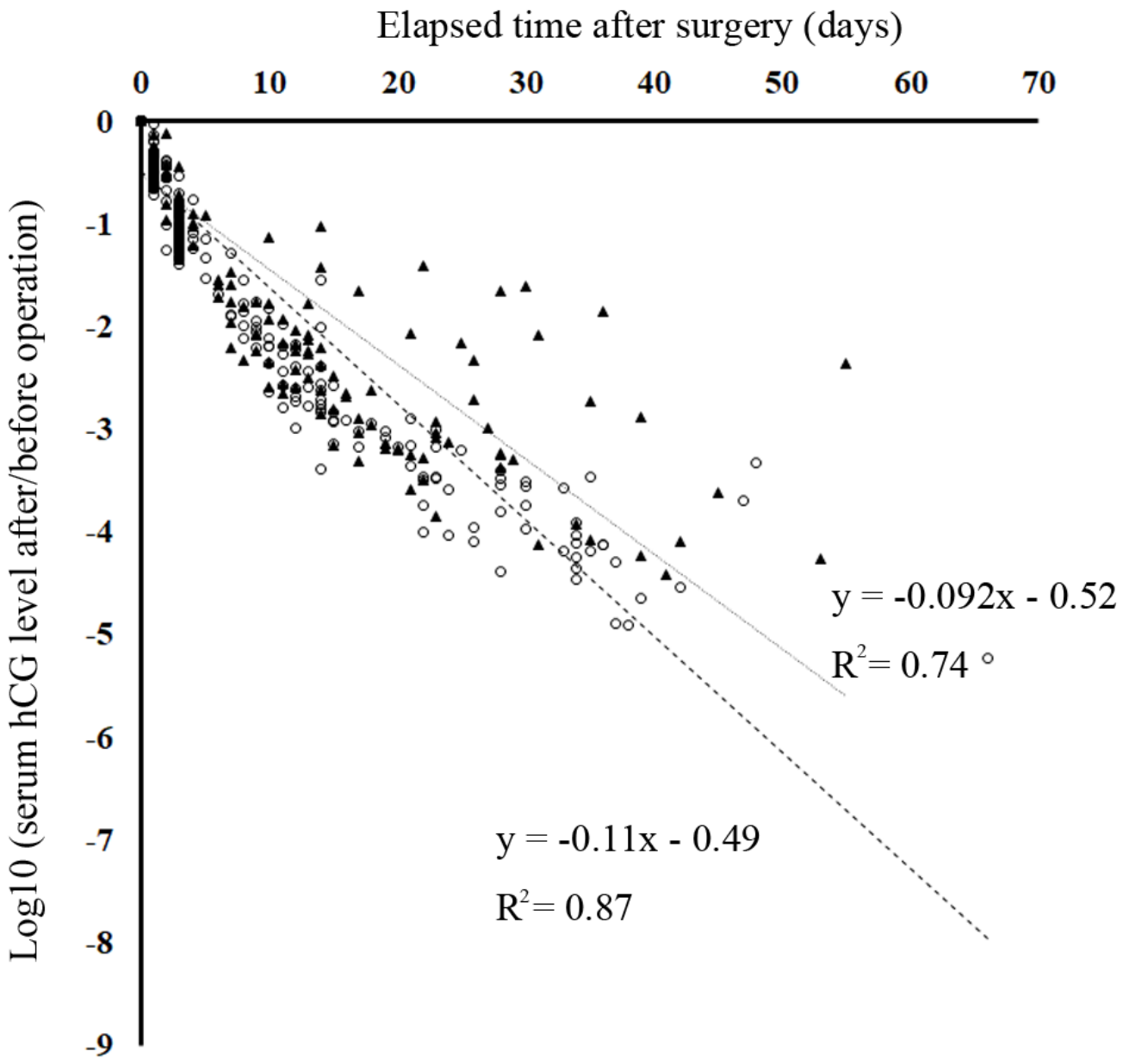

Figure 1

Reduction rate of serum hCG levels after surgery.

The reduction rates of serum hCG levels after laparoscopic salpingostomy (black triangles) and salpingectomy (white circles) are shown with regression lines and R^2 values. X-axis: elapsed time after surgery (days). Y-axis: Log10 (serum hCG level after/before operation (mIU/mL)).

Abbreviations: Log: logarithm, hCG: human chorionic gonadotropin.