Laparoscopic hysterectomy : predictors of quality of surgery

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Chapter five

Predictors of successful surgical outcome in laparoscopic hysterectomy

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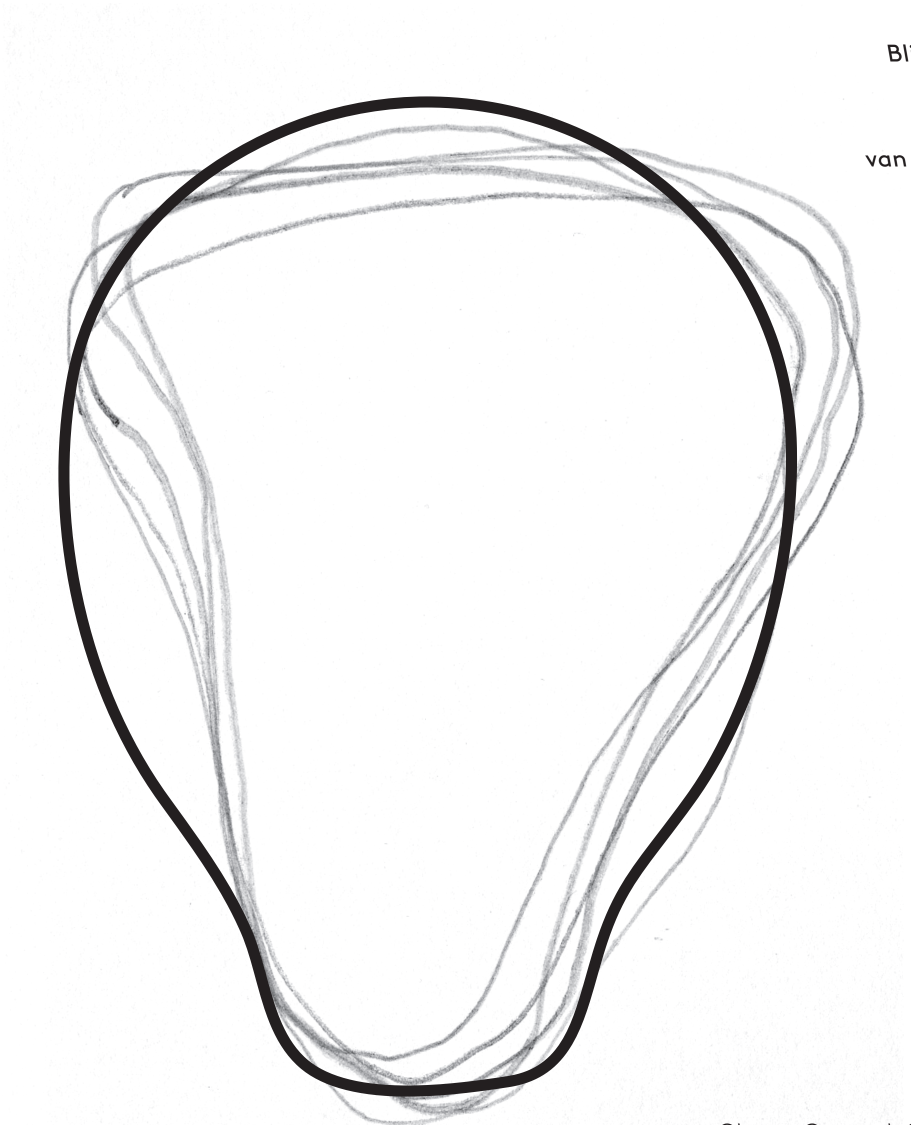

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Abstract

Objective

To estimate, after correction for patient factors, to what extent blood loss, operative time, and adverse events are decisive factors for the successful outcome of laparoscopic hysterectomy. A secondary objective was to estimate to what extent a successful outcome can be predicted from surgical experience or other measures of surgical skill.

Materials and Methods

A nationwide multivariate 1-year cohort analysis was conducted with gynecologists who perform laparoscopic hysterectomy. The primary outcomes were blood loss, operative time, and adverse events. The procedures were corrected for multiple covariates in a mixed-effects logistic regression model. Furthermore, all primary outcomes were related to experience and the influence of individual surgical skills factors.

Results

One thousand five hundred thirty-four laparoscopic hysterectomies were analyzed for 79 surgeons. The success of the surgical outcome was significantly influenced by uterus weight, body mass index, American Society of Anesthesiologists Physical Status Classification, previous abdominal surgeries, and the type of laparoscopic hysterectomy. Surgical experience also predicted the successful outcome of laparoscopic hysterectomy with respect to blood loss and adverse events (P=.048 and .036, respectively). A significant improvement in surgical outcomes tends to continue up to approximately 125 procedures. Independently from surgical experience, an individual surgical skills factor was identified as odds ratio 1.67 and 3.60 for blood loss and operative time, respectively.

Conclusion

After adjusting for risk factors, it was shown that an increase in experience positively predicted a successful outcome in laparoscopic hysterectomy with respect to blood loss and adverse events. However, the independent surgical skills factor shows a large variation in proficiency between individuals. The fact that a surgeon has performed many laparoscopic hysterectomies does not necessarily guarantee good surgical outcome.

Introduction

Laparoscopic hysterectomy has consistently gained in popularity since its worldwide introduction to the surgical palette in the early 1990s.[1-3] Today, it is common knowledge that in cases of benign diseases, if the gold standard (ie, vaginal hysterectomy) is for some reason not feasible, the laparoscopic approach is superior to abdominal hysterectomy with respect to blood loss, wound infection, hospital stay, and recovery period.[4] In addition, patients claim to prefer this minimally invasive approach over abdominal hysterectomy for esthetical reasons and because of recovery considerations.[5]

However, the implementation of laparoscopic hysterectomy is slow and diffuse in the majority of countries, accounting for only 6–16% of all hysterectomies.[6;7] This hampered implementation is assumed to be caused by a number of factors. Firstly, laparoscopic hysterectomy is considered to be an advanced laparoscopic procedure, which is thought to be characterized by a long learning curve.[8;9] However, the few studies that have attempted to describe this learning curve in laparoscopic hysterectomy have all been hampered by their retrospective design and other methodological flaws.[10-14] Chiefly based on complication rates or operative time, these studies state that the learning curve for laparoscopic hysterectomy is completed after approximately 30 procedures.[12;14;15] As a result, the (end of the) learning curve in laparoscopic hysterectomy is not well-defined, whereas a clear definition is important both for training and for reasons relating to ethical and medical–legal issues. Second, probably partly because of the lack of consistent laparoscopic hysterectomy guidelines, performers, and their referring colleagues tend to disagree on the risk factors of laparoscopic hysterectomy.[16-19] Regarding these risk factors (ie, patient characteristics), we identified an ongoing debate in the literature on how the surgical outcome in laparoscopic hysterectomy is influenced by uterus weight, body mass index (BMI, calculated as weight (kg)/[height (m)]2), and the number of previous abdominal surgeries.[20-24] Clearly, more evidence is needed to identify the risk factors that predict successful surgical outcome in laparoscopic hysterectomy and to assist gynecologists in selecting and counseling patients who will benefit from the laparoscopic approach. Applying the data from our nationwide prospective cohort of gynecologists who performed laparoscopic hysterectomies, we tried to estimate which patient and surgeon factors predict surgical outcome in laparoscopic hysterectomy.

Materials and Methods

Every gynecologist in the Netherlands who performed laparoscopic hysterectomies was requested to enroll in this study and to register every laparoscopic hysterectomy performed as a primary surgeon for a period of 12 consecutive months. Before the start of this LapTop! study (Laparoscopic Advanced Procedures, Testing Overall Parameters), every participant was provided with a short questionnaire to assess years of experience with laparoscopic surgery in general and laparoscopic hysterectomy in particular. A concise set of patient and procedure characteristics was defined in a consensus meeting of six gynecologists who had extensive expertise in advanced laparoscopic surgery. At this meeting, the results of a literature search on relevant procedure and patient characteristics were also discussed. In addition to date of birth and indication for laparoscopic hysterectomy, patient characteristics consisted of BMI, age, American Society of Anesthesiologists Physical Status Classification,[25] number of previous abdominal surgeries, and uterus weight (measured in grams, weighed in the operating room). Procedure characteristics included surgery outcomes such as blood loss measured in milliliters, operative time measured in minutes from first incision until final stitch, adverse events, and whether conversion to laparotomy was performed. Performer characteristics included actual number of laparoscopic hysterectomies performed, including the procedure to be registered. Furthermore, the surgeon was asked to register whether the procedure was performed by one or by two gynecologists. If surgery was performed by two surgeons, then the experience of the primary surgeon was registered.

Because of its observational and anonymous character, this study was exempted from approval by our Institutional Review Board. The electronic study record form was designed as an interactive PDF to facilitate swift registration in the operating room. Data were automatically sent to a central study data server. In the event of adverse events observed after sending the record form, a new form could be forwarded. Adverse events were registered by type of complication, severity (ie, requiring re-intervention or not), and moment of onset for a period of up to 6 weeks after discharge (ie, marking the end of the legitimate adverse event reporting period) according to the definitions and regulations as determined by the Guideline on Adverse Events of the Dutch Society of Obstetricians and Gynecologists.[26] Conversion to laparotomy was defined as a switch to an open procedure after laparoscopic start-up.

We aimed to minimize the possibility of incomplete participation because registration was voluntary and participants could hypothetically omit less successful procedures from registration. Therefore, in return for the efforts made, a periodic electronic personal outcomes overview was provided to motivate participation. Furthermore, complete participation was assured by the guaranteed anonymity of the results of each participant, by double-checking the numbers of laparoscopic hysterectomies received with publicly accessible year reports, and, finally, by randomly visiting 10% of the participating centers for a double-check of the surgeons' reports.

We considered blood loss, operative time, and an adverse event to be decisive factors for the successful outcome of laparoscopic hysterectomy, and these outcomes were related to surgeon experience corrected for uterus weight, BMI, age, American Society of Anesthesiologists classification, previous abdominal surgeries, type of laparoscopic hysterectomy (laparoscopically assisted vaginal hysterectomy, supracervical laparoscopic hysterectomy, total laparoscopic hysterectomy) and the number of surgeons performing hysterectomy.

For the statistical analysis, we used SPSS 17.0 and R 2.10.1. Differences between groups were assessed with the [chi]2 test for proportions and Student independent samples t test, or by using the one-way analysis of variance for continuous variables. We calculated standard deviations and odds ratios (ORs). As explained in more detail, we used multivariate mixed-effects logistic regressions to estimate the effects (in terms of log OR) of the relevant risk factors on our outcome variables. A log odds can be converted to an OR by raising e to the power of the log odds.

We used 95% confidence intervals (CIs) and considered $P<.05$ to be statistically significant. We did not correct for multiple comparisons but did report all the tests we performed.

The two numeric outcomes (blood loss and operative time) were dichotomized by setting threshold values to distinguish a successful procedure from an unsuccessful one. For operative time and blood loss, we decided to set the threshold at the rounded mean observed. The third primary end point, adverse event, was already binary. Thus, for all three primary end points, the outcome was binary: success or failure. As a result, in our analysis we did not take into account the raw linear data of blood loss and operative time but applied the binary outcomes to differentiate between successful and unsuccessful procedures (as compared with the mean observed).

We used logistic regression to estimate the influence of various patient characteristics on the outcome. As covariates, we included: BMI, age, American Society of Anesthesiologists classification, previous abdominal surgeries, uterus weight, applied laparoscopic hysterectomy technique (laparoscopically assisted vaginal hysterectomy, supracervical laparoscopic hysterectomy, or total laparoscopic hysterectomy), and whether the surgery was performed by one or two surgeons.

We had to take into account the fact that we observed multiple procedures for each surgeon. Two procedures performed by the same surgeon tend to be “more similar” than two procedures performed by two different surgeons. We modeled this type of similarity by using a mixed-effects logistic regression, thus including random contributions specific to each surgeon. This resulted in the calculation of an individual surgical skills factor. There was no restriction on the type of relation brought about by the effect of experience because a mixture of splines was used. Moreover, in this way, the standard deviation of the random contributions (estimated at log odds of the exponent) demonstrated the size of the surgical skills factor with regard to each primary outcome. Using this approach, the surgical skills factor calculated could be used as an average OR for a successful procedure between two randomly selected surgeons.

Because our model corrects for all measurable patient and surgeon factors, this standard deviation can be interpreted as an OR of surgical factors that are not measurable as a number with a unit, such as the surgical skills and the functionality of the complete operating team.

Because the latter is also the responsibility of the surgeon, we referred to this as the surgical skills factor. To fit this generalized additive mixed model, we used the function gamm in the R package mgcv by Simon Wood.[27]

Results

Seventy-nine out of a total number of 106 gynecologists performing laparoscopic hysterectomy in the Netherlands registered every laparoscopic hysterectomy over a consecutive period of 1 year (response rate 75%). Participants were recruited by 42 out of the 62 gynecology departments performing laparoscopic hysterectomies (laparoscopic hysterectomy hospital cover factor 68%).

The distribution of experience at the start of the study is shown in Figure 1. Approximately 29% of the participating gynecologists had performed 10 or fewer laparoscopic hysterectomies at the beginning of the study, and 50% had performed 30 or fewer laparoscopic hysterectomies at the moment of inclusion. The median number of previously performed laparoscopic hysterectomies was 28 (range 0–250). During the study period of 12 months, the mean number of performed laparoscopic hysterectomies was 14.9 per year (SD 10.7, range 1–50), 43% of the participants performed 10 or fewer laparoscopic hysterectomies per year during the study period, 34% performed between 10 and 20 laparoscopic hysterectomies per year, and 23% performed more than 20 laparoscopic hysterectomies per year.

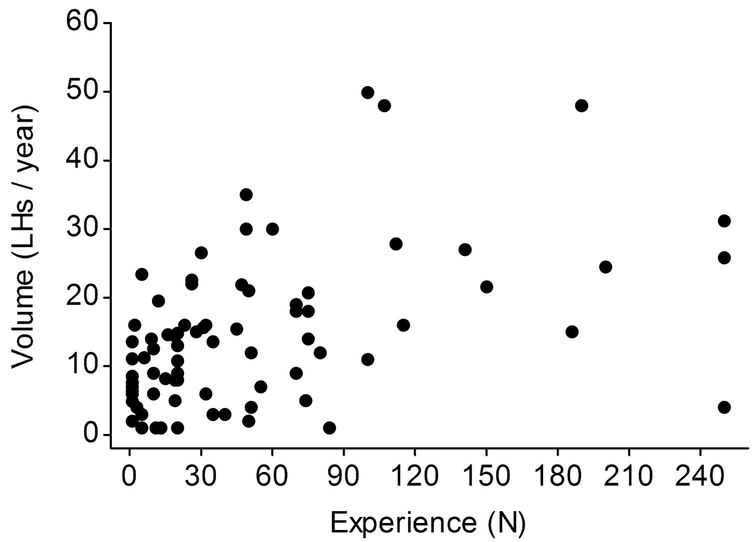

Figure 1 Scatterplot representing experience (number of previously performed LHs) at inclusion plotted against surgical volume (numbers of LHs performed during the study period of one year). $R=0.46$, $P < 0.001$. N= 79 gynecologists. (LH= Laparoscopic Hysterectomy).

A total of 1,585 laparoscopic hysterectomies were registered. Twenty-nine robot laparoscopic hysterectomies, 16 conventional radical laparoscopic hysterectomies, and six laparoscopic hysterectomies with accompanying stage 3 or 4 endometriosis were excluded from analysis to enhance comparability between laparoscopic hysterectomies. A double-check of the number of procedures performed in publicly accessible year reports and by means of a random visit to 10% of the participating centers confirmed the quoted number of procedures registered per center.

The final analysis included 1,534 laparoscopic hysterectomies. The procedure and patient characteristics, together with adverse events and conversion statistics for each type of laparoscopic hysterectomy, are outlined in Table 1. Mean operative time was 116 minutes (SD 42, median 110, range 32–344), mean blood loss was 185 mL (SD 247, median 100, range 0–2,600), and adverse event rate was 7.6%. Procedure characteristics and patient characteristics varied significantly between the three types of laparoscopic hysterectomy. Supracervical laparoscopic hysterectomy was associated with the shortest mean operative time and the highest mean uterus weight. Blood loss was significantly higher in laparoscopically assisted vaginal hysterectomy compared with the other laparoscopic hysterectomy types ($P=.002$). Patients in the supracervical laparoscopic hysterectomy group were significantly younger, less obese, and had a lower American Society of Anesthesiologists classification ($P<.001$, .009, and .007, respectively). General adverse events did not differ significantly between types of laparoscopic hysterectomy (adverse event rate 7.6%). Regarding specific adverse outcomes, blood loss more than 1 L was observed significantly more often in laparoscopically assisted vaginal hysterectomy compared with supracervical laparoscopic hysterectomy and total laparoscopic hysterectomy combined (OR 2.46, 95% CI 1.18–5.11), whereas bladder lesions (n=13, 0.9%) were observed exclusively in the total laparoscopic hysterectomy group. The aforementioned calculations were based on pure observation, without correction for patient and surgeon characteristics.

Adverse events and rounded mean values of operative time and blood loss were used as cut-off points for our definition of successful surgery (blood loss less than 200 mL: n=996, operative time less than 120 minutes, n=852). Other more extreme cut-offs (blood loss 500 mL, operative time 150 minutes) did not significantly affect outcomes as presented. The distribution of operative time and blood loss were skewed (1.1 and 4.4, respectively), justifying dichotomization of these outcomes, as described in the Materials and Methods section.

Tables 2, 3, and 4 show all patient and procedure characteristics (ie, BMI, age, American Society of Anesthesiologists classification, previous abdominal surgery, uterus weight, applied type of laparoscopic hysterectomy, and one or two surgeons present at hysterectomy) identifying the influence of each covariate for successful surgery with respect to blood loss less than 200 mL, operative time less than 120 minutes, and no adverse event. Significant covariates that decreased the chance of lower than average blood loss (blood loss less than 200 mL) were an increase in uterus weight (OR 0.70, 95% CI 0.65–0.75), an increase in BMI (OR 0.77, 95% CI 0.68–0.89), and laparoscopically assisted vaginal hysterectomy instead of total laparoscopic hysterectomy (OR 0.46, 95% CI 0.29–0.74). Significant covariates decreasing the chance of lower than average operative time (operative time less than 120 minutes) were an increase in uterus weight (OR 0.66, 95% CI 0.60–0.72) and laparoscopic hysterectomy being performed by two surgeons instead of

Table 1 Procedure and patient characteristics for each type of laparoscopic hysterectomy

	Total n = 1.534	LAVH n = 183 (12%)	SLH n = 391 (25%)	TLH n = 960 (63%)	*P* value*
Procedure characteristics					
Operative time (min)	116 ± 42	114 ± 35	112 ± 49	118 ± 40	.021
Blood loss (mL)	185 ± 247	238 ± 302	195 ± 266	170 ± 226	.002
Uterus weight (g)	227 ± 199	165 ± 131	280 ± 221	217 ± 196	<.001
Patient characteristics					
Age (years)	47.8 ± 10.2	47.1 ± 10.4	45.9 ± 6.0	48.8 ± 11.3	<.001
BMI (kg/m2)	27.2 ± 5.3	27.3 ± 4.8	26.5 ± 4.8	27.5 ± 5.7	.009
No former abdominal surgery	24.6	30.1	26.6	22.8	.066
ASA classification 1	66.9	63.9	73.4	55.9	.007
Main indications					
Dysfunctional uterine bleeding	50	62	55	45	
Myomata	27	14	40	25	
(Pre)malignancy	15	14	0.5	22	
Pelvic pain	2	1.5	1.5	2.5	
Complicated procedures	116 (7.6)	19 (10.4)	22 (5.6)	75 (7.8)	.119
Requiring re-intervention (%)	23 (1.5)	5 (2.7)	3 (0.8)	15 (1.6)	.189
Top five complications					
Lesion	31 (2.0)	5 (2.7)	2 (0.5)	23 (2.4)	.142
Bladder	13 (0.9)	-	-	1.4 (13)	.020
Ureter	7 (0.5)	2 (1.1)	-	4 (0.4)	.366
Vessel	3 (0.2)	2 (1.1)	-	1 (0.1)	.224
Intestine	8 (0.5)	1 (0.6)	2 (0.5)	5 (0.5)	.999
Blood loss > 1L	43 (2.8)	10 (5.5)	11 (2.8)	22 (2.3)	.033
Infection	12 (0.8)	1 (0.6)	1 (0.3)	10 (1.0)	.480
Wound dehiscence	15 (1.0)	2 (1.1)	3 (0.8)	10 (1.0)	.688
Technical failure	6 (0.4)	1 (0.6)	2 (0.5)	3 (0.3)	.815
Conversions to laparotomy	71 (4.6)	12 (6.6)	13 (3.3)	46 (4.8)	.221
Proportion due to complication (%)	31	42	54	22	.178

Data are mean +/- standard deviation, %, or n (%) unless otherwise specified.

* ANOVA test was used for continuous variables; Chi-square test was used for proportions.

Table 2 Influence of each covariate on successful surgical outcome with respect to blood loss less than 200 mL

	Odds Ratio	95%-CI		*P* value
		Lower	Upper	
Procedure characteristics				
LAVH (compared to TLH)	0.46	0.29	0.74	.001
SLH (compared to TLH)	1.04	0.73	1.49	.810
Two surgeons (compared to one)	1.21	0.77	1.92	.413
Patient characteristics				
Age (increase per year)	1.00	0.99	1.02	.599
Uterus weight (increase per 100 gr)	0.70	0.65	0.75	<.001
BMI (increase per 1 kg/m²)	0.77	0.68	0.89	<.001
ASA 2 (compared to ASA 1)	0.84	0.60	1.16	.291
ASA 3 (compared to ASA 1)	0.52	0.21	1.28	.156
Numbers of prior abdominal surgeries				
One (versus none)	0.93	0.68	1.26	.616
Two (versus none)	0.80	0.50	1.27	.345
Three or more (versus none)	0.75	0.36	1.53	.424

Table 3 Influence of each covariate on successful surgical outcome with respect to operative time less than 120 minutes

	Odds Ratio	95%-CI		*P* value
		Lower	Upper	
Procedure characteristics				
LAVH (versus TLH)	0.81	0.44	1.47	.483
SLH (versus TLH)	1.58	1.04	2.41	.032
Two surgeons (versus one)	0.55	0.30	0.99	.045
Patient characteristics				
Age (increase per year)	0.99	0.97	1.01	.201
Uterus weight (increase per 100 gr)	0.66	0.60	0.72	<.001
BMI (increase per 1 kg/m²)	0.92	0.79	1.06	.242
ASA 2 (versus ASA 1)	0.95	0.67	1.35	.792
ASA 3 (versus ASA 1)	0.40	0.15	1.11	.078
Numbers of prior abdominal surgeries				
One (versus none)	0,90	0,65	1,25	.538
Two (versus none)	0,94	0,57	1,55	.798
Three or more (versus none)	0,55	0,26	1,17	.122

Table 4 Influence of each covariate on successful surgical outcome with respect to no adverse event

	Odds Ratio	95%-CI		P value
		Lower	Upper	
Procedure characteristics				
LAVH (versus TLH)	0.88	0.46	1.70	.705
SLH (versus TLH)	1.67	0.93	3.01	.089
Two surgeons (versus one)	1.08	0.55	2.15	.820
Patient characteristics				
Age (increase per year)	1.00	0.98	1.03	.772
Uterus weight (increase per 100 gr)	0.84	0.76	0.92	<.001
BMI (increase per 1 kg/m^2)	1.08	0.85	1.39	.522
ASA 2 (versus ASA 1)	0.97	0.54	1.72	.911
ASA 3 (versus ASA 1)	0.31	0.08	1.21	.092
Numbers of prior abdominal surgeries				
One (versus none)	0.55	0.33	0.91	.020
Two (versus none)	1.21	0.45	3.26	.704
Three or more (versus none)	0.30	0.11	0,81	.017

one (OR 0.55, 95% CI 0.30–0.99). However, performing supracervical laparoscopic hysterectomy instead of total laparoscopic hysterectomy increased the probability of operative time less than 120 minutes (OR 1.58, 95% CI 1.04–2.41). Significant covariates decreasing the chance of an uneventful procedure were increased uterus weight (OR 0.84, 95% CI 0.76–0.92) and previous abdominal surgeries (one previous abdominal surgery: OR 0.55, 95% CI 0.33–0.91; more than two previous abdominal surgeries: OR 0.30, 95% CI 0.11–0.81).

Figure 2 shows the influence of experience (ie, previous numbers of performed laparoscopic hysterectomies) on the log odds (ie, probability) of a successful laparoscopic hysterectomy with respect to blood loss less than 200 mL, operative time less than 120 minutes, and no adverse event. We found a significant effect of experience on both blood loss (P=.048) and an adverse event (P=.036). The effect of experience on operative time was not significant (P=.2). Additionally, surgical volume (numbers of performed laparoscopic hysterectomies per surgeon during the study period) did not significantly predict successful outcomes in laparoscopic hysterectomy with respect to blood loss less than 200 mL, operative time less than 120 minutes, and an adverse event (P=.20, .85, and .49, respectively). Surgical volume and experience were moderately correlated (R=0.46, P<.001; Fig. 1).

The random contributions specific to each surgeon and used in our mixed-effects logistic regression model captured the fact that some surgeons appeared to be intrinsically more skilled than others; we defined this as the surgical skills factor. The surgical skills factor varied between the three assessed outcomes. The standard deviation of this random effect was estimated at a log

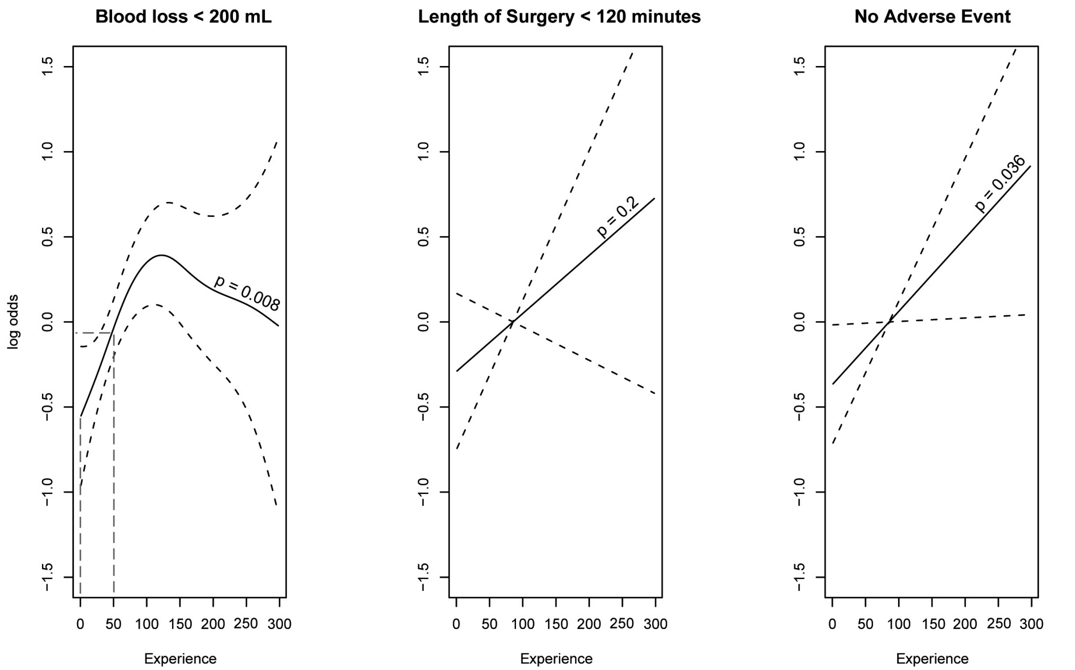

Figure 2 Graphic representation of the increasing probability of performing a successful LH with an increase in experience (numbers of performed LHs); with respect to blood loss < 200 milliliters (P = .008), operative time < 120 minutes (P = .2) and no adverse event (P = .036). The dotted black lines represent 95% confidence intervals. (LH= Laparoscopic Hysterectomy)

odds of 0.51 for blood loss less than 200 mL. This means that for two randomly selected surgeons, we calculated an average OR of 1.67 for blood loss less than 200 mL (exp (0.51)), comparable to a difference in success probability for a difference in experience between 0 and 50 procedures (dotted lines in left graph of Fig. 2). For operative time, this surgical skills factor OR was 3.60 (exp (1.28)). For adverse event, the surgical skills factor OR was 1.00 (exp (less than 0.001), ie, we detected no significant surgical skills factor for adverse event).

In the standard logistic regression model, the effect of a covariate on the log odds was assumed to be linear. For the outcome blood loss less than 200 mL, there was evidence of a nonlinear effect. After adjusting for all other covariates, success probability increased up to approximately 125 procedures. Beyond 125 procedures, no further gain was detected. With respect to operative time and adverse event, this cohort did not provide enough evidence for a departure from a linear effect.

Discussion

Our nationwide, prospective, multivariate cohort analysis of gynecologists performing laparoscopic hysterectomy shows that surgical experience predicts successful outcome in laparoscopic hysterectomy with respect to blood loss and adverse events. Surprisingly, a successful outcome in laparoscopic hysterectomy does not depend on surgical volume (expressed in the numbers of procedures performed during the study period).

This study provides us with risk-adjusted predictors for successful laparoscopic hysterectomy. Multiple risk factors such as uterus weight, BMI, previous abdominal surgery, type of laparoscopic hysterectomy, and one compared with two surgeons were identified. With respect to these factors, the present study confirms the findings in the literature.[20;28-30] Increased uterus weight, increased BMI, and performing a laparoscopic assisted vaginal hysterectomy (instead of supracervical laparoscopic hysterectomy or total laparoscopic hysterectomy) increased the amount of blood loss, performing laparoscopic hysterectomy with two surgeons seemed to slow down the procedure, and the risk of an adverse event increased in cases involving a history of abdominal surgeries.

Furthermore, the number of procedures required to acquire a steady rate of successful surgical outcomes in laparoscopic hysterectomy differed considerably from former (retrospective) learning curve studies that reported that 30 procedures were needed to reach proficiency.[10-14] The present study showed, however, that a significant improvement with respect to blood loss and adverse events could still be observed far beyond the aforementioned thirty procedures. With respect to the entire cohort, we identified a significant improvement up to approximately 125 procedures for blood loss less than 200 mL. This gain in experience did not decrease with respect to adverse events. Furthermore, we observed an intrinsic surgical skills factor independent from experience. This finding indicates that skills vary significantly among surgeons. It is therefore reasonable to assume that proficiency in laparoscopic hysterectomy should not be based solely on the number of procedures performed. Moreover, although experience did not predict a decline in operative time, we detected a significant variation in surgical skills factor with respect to this factor, ie, independently from experience, some surgeons tended to operate significantly faster than others. However, as the risk of causing an adverse event significantly declined with increasing experience, we detected no significant variation in surgical skills factor with respect to this factor, ie, two randomly selected gynecologists with the same amount of experience will have a comparable chance of an adverse event occurring.

We observed that experience significantly influenced outcomes with regard to blood loss and adverse events. Operative time was not significantly influenced by experience. These outcomes differ greatly from those of former studies.[31] This might be attributable to the fact that the present study prospectively investigated an entire cohort of gynecologists performing laparoscopic hysterectomy, each with their own level of experience. Previous studies mainly consisted of retrospective reports of a single surgeon's experiences with a newly acclaimed technique, without correcting for patient characteristics.[10-14;32] Our results call into question the definition of proficiency with respect to a given surgical technique.[15] We might follow the aforementioned single-surgeon studies in defining proficiency in terms of the number of procedures performed, which might then reach a plateau after a certain number of procedures. Alternatively, we suggest that proficiency can be defined as a level of performance that is as successful as the average measured for the entire cohort. We are convinced that this allows for a much better estimate of surgical expertise than only taking into account the number of procedures performed.

One might say that the cut-off values for unsuccessful procedures as defined by the median observed operative time (less than 120 minutes) and blood loss (less than 200 mL) are rather low. However, the same significant associations were found in analyses with other cut-off values, such as operative time less than 150 minutes and blood loss less than 500 mL. The probability of an operative time less than 120 minutes was significantly decreased if two surgeons performed the surgery. Hypothetically, this might be attributable to the fact that these laparoscopic hysterectomies were performed in a mentorship setting. Compared with other studies, the mean estimated blood loss observed is rather high. Hypothetically, this might be attributable to the fact that most other studies were single-center or single-surgeon–based reports. The results of the present study, however, reflect actual population-based estimated blood loss levels.

The substantial variation in surgical skills factors observed between individuals raises the question of whether it is possible for any individual to learn to perform a laparoscopic hysterectomy properly. A study on basic laparoscopic skills training outside the operating theater showed that up to 20% of trainees failed to become adequately proficient in minimally invasive surgery, which seems to support this hypothesis.[33] In our study, despite correction for risk factors, type of laparoscopic hysterectomy applied, and whether surgery was performed by one or two surgeons, a significant surgical skills factor for successful surgery still remained with respect to blood loss (OR 1.67) and operative time (OR 3.6).

Because we have identified a wide variation in proficiency in laparoscopic hysterectomy, we would like to continue to find tools to identify individual skills factors after correction for patient and procedure characteristics based on national or even international averages. To meet the persistent call for continuous quality assessments in surgery, we feel that there is a need for an ongoing proficiency check in laparoscopic hysterectomy.[34] We hope that future research will, for instance, assess the usefulness of cumulative summation analysis for determining a proficiency range in laparoscopic hysterectomy and distinguish adequate performers from less competent surgeons.[35-37] Because ultimate proficiency in advanced laparoscopic surgery might be regarded as a rather unrealistic goal, the maintenance of operative skills should become the real measure of this lifetime learning curve.[38]

Apart from the expected finding that successful surgical outcome depends on experience, our results show that successful laparoscopic hysterectomy also depends on an individual surgical skills factor and that this success rate varies significantly among individuals. According to our results, one should be cautious in adopting a general 30-procedure mantra for the learning curve involved in surgery. Instead, one should try to estimate individual learning curves by regularly comparing individual outcomes and adverse events with a national or even international cohort. This will inevitably result in a focus on the maintenance of individual surgical skills that will enhance and guarantee the patient-safe performance of laparoscopic hysterectomy.

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