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Laparoscopic surgery in gynecology : studies about implementaion and training

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The implementation of the
laparoscopic simulator
in gynecological residency curriculum

Abstract

Background: In view of the current emphasis on increasing patient safety and quality control in laparoscopic surgery, a growing need exists to improve laparoscopic training. This study was conducted to investigate if and when residents reached performance standards for basic laparoscopic skills and to analyse the current state of implementation of laparoscopic simulators in gynecological residency curriculum.

Methods: Residents across all 6 years of residency (post-graduate year (PGY) 1-6) were tested once on our simulator (box trainer) by performing 5 inanimate tasks (pipe cleaner, rubber band, beads, cutting circle, intra-corporeal knot tying). A sumscore for the 5 tasks was calculated for each participant (sum of all scores). Scores were calculated by adding completion time and penalty points, thus rewarding both speed and precision. These data were compared with scores of laparoscopic experts, which were set as performance standards.

Results: Of the participants, 111 were residents (7 PGY1, 27 PGY2, 29 PGY3, 28 PGY4, 14 PGY5, 6 PGY6) and 8 were experts. At the end of residency, PGY6 residents reached performance standard for all tasks, except for intra-corporeal knot tying. It was not until PGY5 that residents reached performance standard for pipe cleaner task, PGY1 for rubber band, PGY5 for beads, PGY4 for circle cutting and PGY6 for sumscore. Throughout residency PGY6 only had a mean total of 3.6 hours of simulator training experience. No correlation was found between this previous simulator training experience and performance on our simulator during this study (sumscore), and between previous simulator training and total laparoscopic procedures performed. In a combined multivariate analysis, sumscore performance remained significantly associated with the number of laparoscopic procedures performed by residents as a primary surgeon ($p=0.002$), and not with the cumulative hours of simulator training during residency prior to participating in this study ($p=0.15$).

Conclusions: In current Dutch gynecological residency curriculum, residents do not reach all performance standards for basic laparoscopy. We conclude that voluntary simulator training program has a substantial risk to fail and the implementation of the laparoscopic skills simulator in current residency curriculum is still in its infancy.

Introduction

Laparoscopic surgery in gynecology has evolved into a major surgical approach to treat a variety of gynecologic disorders. However, a major limitation for laparoscopy is training. The decrease in residents' working hours [Haluck 2000] and major gynecological procedures [Brölmann 2001] leads to less exposure in the operating room and relatively smaller case volumes for residents in training. [Blanchard 2004] Therefore, residents may not be optimally exposed to this type of surgery. [Kolkman 2005]

There is consensus that laparoscopic skills training should be intensified and assessment of skills should be introduced to ensure good quality of patient care. [Grantcharov 2003, Schijven 2003] Simulators are devices that recreate operative conditions and offer the possibility of training outside the operating room. They are gaining territory as means of training [Rosser 1997, Derossis 1998, Jordan 2001, Scott 2001, Fried 2004] and objective assessment of laparoscopic skills. [Reznick 1997, Derossis 1999, Jordan 2001, Lentz 2001, Fraser 2003, Feldman 2004, Fried 2004] In addition, simulator training has been shown to be effective in providing skills that are transferable to the operating room [Anastakis 1999, Fried 1999, Scott 2000, Jordan 2001, Torkington 2001, Traxer 2001, Hamilton 2002, Seymour 2002, Hyltander 2002, Grantcharov 2003, Grantcharov 2004, Schijven 2005] Simulators allow repeated practice of standardized tasks and provide unbiased and objective measurements of laparoscopic performance, however their wide application in training programs is not yet generally accepted. [Kolkman 2005]

At the department of gynecology of the Leiden University Medical Center a skills laboratory (surface of 25 m²) with box trainers (video trainers) and inanimate tasks was established in 2002. Bimonthly simulator training classes were organized and supervised by laparoscopic experts and residents were stimulated to train during a quiet moment in their shift or in their own time. Simulator training was not structured in the residents' curriculum and the amount of training was a resident's own responsibility.

Implementation studies emanated from Medical Technology Assessment and investigate the actual incorporation of a new technology into daily practice. Studies were undertaken to assess the validity and the implementation of our simulation model in residency training. Previously, we have shown that our simulation model has construct validity to differentiate between skills levels of novices and laparoscopic experts. In addition, the performance of laparoscopic experts performance on our simulator was set as performance standard, which is shown to be feasible, given that laparoscopic novices can be trained to reach the basic skills level of experts after a short training program on our simulator. [Kolkman, submitted 2006]

The aim of the current study was to investigate if and when residents reach performance standards for laparoscopy during current residency curriculum. Furthermore, the effect of simulator training and experience in laparoscopy (acquired prior to participating in our study) on performance on our simulation model were measured.

Methods

This study was performed in the skills laboratory located at the Department of Gynecology of the Leiden University Medical Center (LUMC) in The Netherlands. The simulator was designed (F.W.J.) and fabricated at the LUMC. It consisted of an inanimate 5-task box trainer with a non-transparent cover, measuring 45 x 30 x 25 cm using a 0° scope. [Kolkman, submitted 2006]

Participants

Between 2003 and 2005 Dutch residents in obstetrics-gynecology of all postgraduate years (PGY1 – PGY6) participated in our study. All residents completed the 5 simulator tasks once.

These data were compared to data from our previous study, in which construct validity and laparoscopic performance standards of our simulation model were established. Performance standard was set at experts' scores on our simulator. [Kolkman, submitted 2006]

Experts each performed more than 100 advanced laparoscopic procedures. Residents' scores were compared to the scores of laparoscopic experts, in order to investigate if and when residents reached performance standards for basic laparoscopic skills during current residency curriculum.

The year in which PGY reached performance standard was defined as the first year in which no significant difference was found between the mean scores of residents and experts.

The number of hours of simulator training and the number of laparoscopic cases performed as primary surgeon prior to taking part in this study for each participating resident were registered, in order to investigate their effect on residents' performance on our simulation model.

Outcome measures

The tasks and outcome measures are described in Chapter 6 [Kolkman, submitted 2006].

Statistics

Collected data were analysed by SPSS 12.0 software package (SPSS, Chicago, Illinois,

USA). Statistical analyses were performed using t-tests and linear regression (univariate and multivariate analyses). P-values below 0.05 were considered statistically significant.

Results

During the study period 111 residents of all postgraduate years (PGY) participated (7 PGY1, 27 PGY2, 29 PGY3, 28 PGY4, 14 PGY5, 6 PGY6). Mean scores with standard deviations of PGY1 to PGY6 residents and experts are stated in table 1.

Residents showed an improvement in mean score for all tasks and sumscore during the 6 years of residency training, as shown in figure 1a-1f. At the end of residency training, residents (PGY6) reached the performance standard for 4 out of 5 tasks, since for these 4 tasks no significant difference was found between mean PGY6 scores and expert scores. PGY1 residents reached performance standard for the rubber band task, PGY4 for circle cutting, PGY5 for pipe cleaner task and beads and PGY6 for sumscore. PGY6 did not reach performance standard for intra-corporeal knot tying ($p < 0.05$).

The mean total number of laparoscopic procedures performed by residents as primary surgeon prior to participating in this study across all years of training and ranges were calculated and shown in figure 2. PGY1 had performed a mean of 13 (range 0-29) laparoscopic procedures, PGY2 27 (range 2-64), PGY3 44 (range 0-186), PGY4 86 (range 6-341), PGY5 125 (range 75-222) and PGY6 77 (range 12-123). A significant correlation was demonstrated between the total laparoscopic procedures performed by residents as a primary surgeon and sumscore performance (Spearman $p < 0.001$, correlation coefficient -0.368, Pearson $p = 0.003$, correlation coefficient -0.323).

The mean cumulative hours of simulator training during residency prior to participating in this study and ranges were calculated and shown in figure 3. PGY1 had trained a mean of 0.71 (range 0-3) hours, PGY2 1.36 (range 0-6), PGY3 1.07 (range 0-4), PGY4 2.80 (0-10), PGY5 2.43 (range 0-10) and PGY6 3.60 (range 0-9) on a simulator prior to participating in this study. No correlation was demonstrated between previous simulator training experience during residency and sumscore during our study (Spearman -0.155 $p = 0.139$, Pearson -0.146 $P = 0.166$).

No correlation was demonstrated between previous simulator training experience during residency and the number of laparoscopic procedures performed (Pearson -0.01 $p = 0.99$, Spearman 0.11 $p = 0.92$).

Table 1 | Mean scores (range) of participants

	n	Pipe cleaner mean (range)	Rubber band mean (range)	Beads mean (range)	Circle cutting mean (range)	Knot tying mean (range)	Sumscore mean (range)
PGY 1	7	186 (58-479)	184 (89-425)	441 (204-790)	326 (83-687)	578 (338-970)	1.715 (797-2.838)
PGY 2	27	142 (52-497)	129 (45-391)	318 (73-589)	340 (138-1.138)	500 (240-1.057)	1.451 (889-3.129)
PGY 3	29	129 (36-1.050)	113 (35-272)	343 (132-781)	278 (142-703)	487 (125-1.251)	1.327 (470-2.113)
PGY 4	28	144 (27-750)	109 (33-375)	349 (155-758)	264 (114-642)	347 (95-950)	1.168 (582-2.454)
PGY 5	14	91 (48-160)	82 (50-149)	316 (138-634)	281 (154-624)	455 (110-735)	1.241 (799-1.603)
PGY 6	6	143 (29-265)	81 (36-153)	248 (174-320)	254 (152-343)	423 (163-1.926)	1.272 (613-1.926)
Experts *†	5	68 (49-100)	82 (35-195)	237 (111-318)	173 (76-240)	115 (50-177)	659 (351-878)

Lower scores represent better performance, * data from previous study [Kolkman submitted 2006], † performance standards

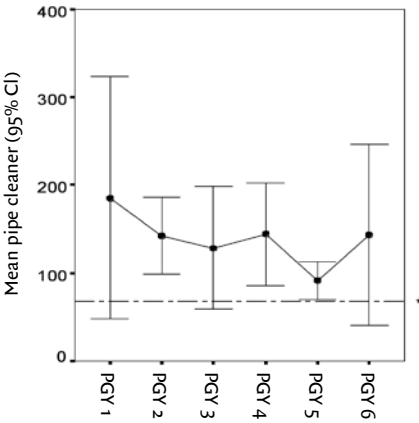


Figure 1a | Mean scores pipe cleaner

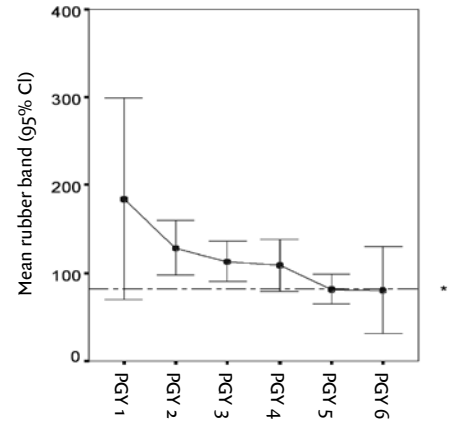


Figure 1b | Mean scores rubber band

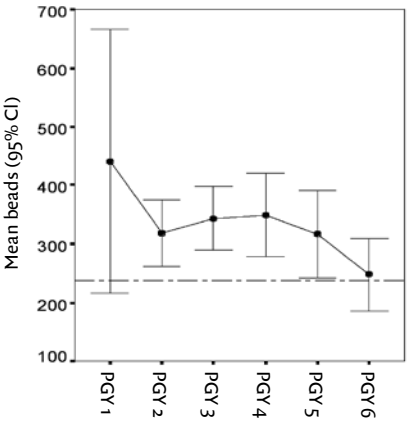


Figure 1c | Mean scores beads

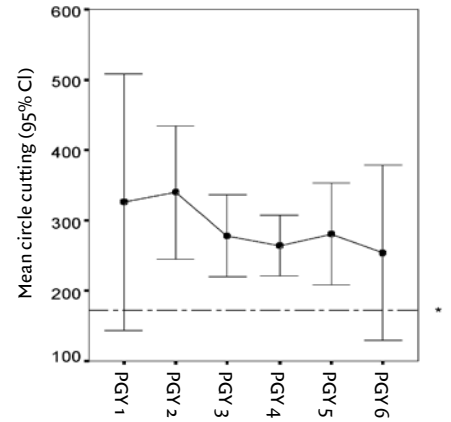


Figure 1b | Mean scores circle cutting

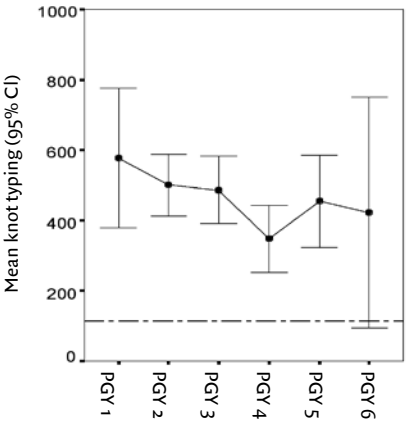


Figure 1e | Mean scores intra-corporeal knot typing

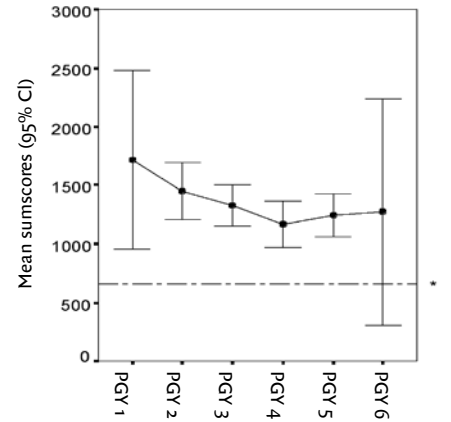


Figure 1f | Mean sumscores

Lower scores represent better performance, CI = confidence interval, *performance standard is mean experts' score

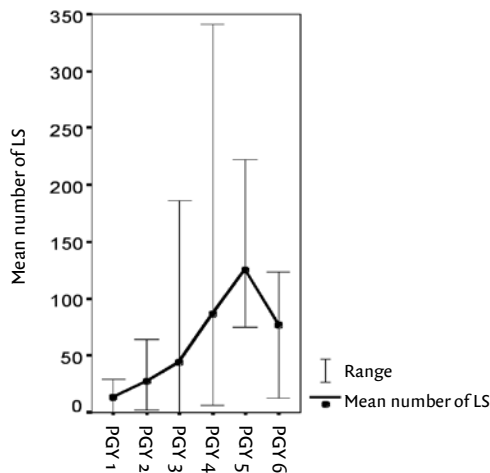


Figure 2 | Mean number (range) of performed laparoscopic procedures during residency training per postgraduate year in current curriculum
LS = laparoscopic procedures

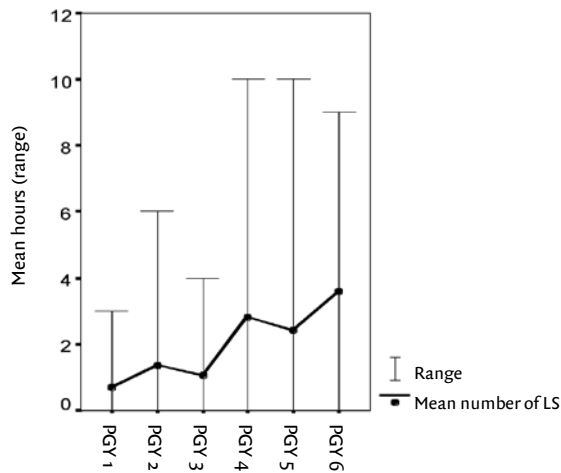


Figure 3 | Mean cumulative hours (range) of simulator training during residency training per postgraduate year in current curriculum.

In a combined multivariate analysis, sumscore performance remained significantly associated with the number of laparoscopic procedures performed by residents as a primary surgeon ($p=0.002$), and not with the cumulative hours of simulator training during residency prior to participating in this study ($p=0.15$).

Discussion

In our current residency program, residents do not reach all performance standards of basic laparoscopic skills and if they do, it is not until the end of 6 years of residency training that they reach these performance standards. We conclude that a voluntary simulator training program has a substantial risk to fail.

All residents should acquire basic laparoscopic skills on a simulator to the level of a performance standard as early as possible during residency, in any case before performing laparoscopic surgery on patients. Unfortunately, due to the fact that the implementation of the laparoscopic skills simulator in the current Dutch gynecological residency curriculum is still in its infancy, in this study the usefulness of our simulator is limited to an assessment tool for clinical laparoscopic experience, rather than a training device.

Surgical curricula should aim at achieving an appropriate level of performance based on performance standards. [Korndorffer 2005] Major advantage of using goal-oriented training is consistency of the final result, since all residents are expected to reach the performance standard. For residents with outstanding innate ability, minimal practice may be required. For those who require more practice, appropriate training may be scheduled until the predetermined level of performance is accomplished. In addition, residents are competitive and thrive from having a goal to achieve. [Korndorffer 2005]

Although experts' basic skills level is shown to be a feasible performance standard on a simulator for laparoscopic inexperienced individuals, [Kolkman, submitted] PGY6 residents did not reach this standard for intra-corporeal knot tying. Vossen et al [Vossen 1997] has described that residents experienced a long learning curve for intra-corporeal knot tying on a simulator, since it is a difficult task. However, plateau was reached in their learning curves after 20-30 trials. [Vossen 1997] Although intra-corporeal knot tying is not frequently performed in the operating room, it is a requirement to be able to perform advanced laparoscopic procedures. Moreover, this task embraces all necessary skills to safely perform laparoscopy, such as eye-hand coordination, two-dimensional representation of a three-dimensional operating field, the fulcrum effect, the handling of long surgical instruments and the diminished tactile feedback. [Scott 2000, Munz 2004] It is our opinion that intra-corporeal knot tying is an outstanding task to train on a simulator and experts' skills level as performance standard should be included in skills training curriculum. [Kolkman 2005]

The majority of residents report a strong need for training outside the operating room and consider simulator training of great importance to their skills in the

operating room. [Kolkman 2005] In current curriculum the amount of simulator training is a resident's own responsibility. This results in a very low frequency of simulator training; in fact 33% of our residents had not taken the effort to use the simulator at all. [Kolkman, submitted 2006] Other studies have shown that training improved performance, [Derossis 1998, Kolkman submitted 2006] however we found no relation between previous simulator training and performance on our simulator in current setting. These results are contradictory and may possibly be explained by the fact that residents spent too little time practicing on a simulator prior to participating in this study to influence performance on our simulator.

On the other hand, laparoscopic surgical experience did have a significant correlation with performance on the simulator (sumscore). Therefore, we conclude that the improvement in performance on the simulator during the years of residency training is a result of increased laparoscopic experience in the operating room. Moreover, the skills obtained in the operating room can be objectively assessed by our simulator.

In a different setting, we have previously shown that our simulation model is an excellent training module which results in better performance, [Kolkman submitted] the current study suggests that our simulation model may be used as a skills assessment tool of clinical experience in the future. In addition to train and objectively evaluate residents' basic laparoscopic skills during residency, it is our goal to develop our simulation model into an evaluation tool to assess experts' basic laparoscopic skills as part of a credentialing or accreditation system. However, we need to keep in mind that our simulation model represents basic laparoscopic skills and that simulator assessment is not the only factor on which credentialing should be based.

The curriculum concerning laparoscopic training needs serious modifications by structuring and standardizing training and its assessment. Besides the bimonthly training classes and mandatory 2-day courses in basic laparoscopic surgery, the design of voluntary simulator training as in the current curriculum has failed. Given that subjects inexperienced with laparoscopy benefit the most from simulator training [Scott 2001, Feldman 2004] and can acquire basic laparoscopic skills to the level of an expert over a short period of time, [Kolkman submitted 2006] we stress that residents need to reach the performance standard as early as possible in residency before participating in live laparoscopic surgery. This way, residents will enter the operating room with a set of basic skills, which undoubtedly will enhance educational opportunities throughout residency. If proficiency in basic skills is present, time in the operating room can be spent on learning anatomy, pathology, and operative techniques instead of basic skill acquisition. [Korndorffer 2005] In addition, early basic skills acquisition may result in an improvement in implementation of advanced laparoscopy into daily practice.

With the mounting evidence of the beneficial aspects of training outside the operating room, there is no excuse for depriving residents of simulator training. It is no longer an added luxury but an essential and mandatory component in the future curriculum. It is of utmost importance to appropriately implement laparoscopic simulators into residency in a mandatory fashion to optimize acquiring and evaluating basic and advanced laparoscopic skills during residency training.

