Acquiring minimally invasive surgical skills

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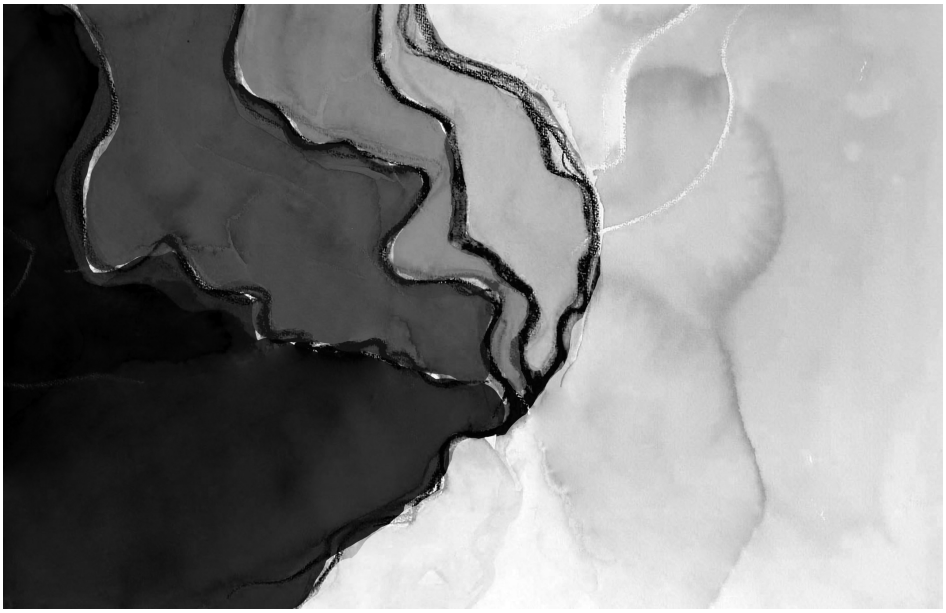
CHAPTER 10

ARE MINIMALLY INVASIVE PROCEDURES HARDER TO ACQUIRE THAN CONVENTIONAL SURGICAL PROCEDURES?



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INTRODUCTION

The psychomotor skilfulness of a surgeon reveals to be one of the most important factors influencing the outcome of a surgical procedure, combined with his or her cognition and personality.[Najmaldin, 2007] Nevertheless, operating room (OR) experience is harder to gain for residents these days. This is mainly due to reduced working hours, financial and ethical constraints.[Hammond & Karthigasu, 2006] Consequently, in order to ensure safe and high quality treatment, the skills training needs to be optimized by means of structured programs and by the implementation of appropriate feedback and assessment during residency to objectively evaluate surgical skills.[Aggarwal et al., 2004]

Recently, an assessment tool has been implemented to objectify surgical skills: the Objective Structured Assessment of Surgical Skills (OSATS). This tool was originally designed to measure technical surgical performance in skills laboratories, and its validity, reliability and feasibility have been established in these settings.[Martin et al., 1997] Additionally, Aggarwal et al. have validated the general global rating scale of the OSATS for real laparoscopic surgery.[Aggarwal et al., 2008] For their validation they used video material recorded by the laparoscopic stalk during laparoscopic cholecystectomies. Furthermore, the OSATS have been validated for use during actual observation during surgery by our study group.[Hiemstra et al., 2011]

The advent of minimally invasive surgery (MIS) has even further increased the interest in skills training and assessment, because it is considered to be a more demanding technique for surgeons than the conventional (open abdominal and /or vaginal) surgery.[Feldman et al., 2004b] Arguments for the complexity of the MIS technique are the long surgical instruments that are required with reduced haptic feedback and fewer degrees of freedom, the altered depth perception resulting from 2D imaging and the necessity to adapt to the fulcrum effect. [Gallagher et al., 1998; Perkins et al., 2002] Therefore, it has often been concluded that MIS requires a longer learning curve than conventional surgery.[Moore et al., 1995; Perkins et al., 2002; Purkayastha et al., 2004] However, this assumption is based on arguments rather than objective measurements.

Although insight in the process of acquiring surgical skills is highly important, data on objective measurements on the surgical learning process during residency are scarce. Therefore, this study was conducted to gain a better insight in the residents' learning process of technical operative skills. Specifically, we tried to find support for the assumption that residents experience more difficulty to acquire MIS procedures than conventional surgical procedures by means of OSATS-based learning curves.

MATERIALS AND METHODS

An observational cohort study was conducted at our university teaching hospital, the Leiden University Medical Centre (LUMC). In general, residents in Obstetrics and Gynaecology (Ob/Gyn) spend three years of their six-years' residency program in a university teaching hospital to be trained in a variety of subspecialties, like reproductive health care, perinatology and oncology. A three months clinical rotation is spent on gynaecological surgery, generally

attended during the fourth postgraduate year (PGY 4). They had gained some prior surgical experience during the first year of training which is spent in the general Ob/Gyn practice in a non-university teaching hospital. This experience was limited to urgent surgery on call, and almost no elective surgery. The second and third year they are mainly trained in obstetrical skills in a university teaching hospital. During the clinical rotation 'gynaecological surgery' during the fourth year of residency, they are scheduled to perform surgery in the OR for four or five days a week. For the numbers and specific type of procedures, they depend on the normal throughput of patients scheduled on the operation program. Parallel to their increase in experience, they gradually perform each procedure more autonomously, depending on their level of performance and patient characteristics. As their increase in responsibility was merely based on the supervisor's general opinion, rather than on more objectively defined measures, this can be taken as training according to the conventional apprenticeship model.

The general global rating scale of the Objective Structured Assessment of Technical Skills (OSATS) was included in the intraoperative assessment of surgical performance. The assessment form was adapted from Martin et al.[Martin et al., 1997] Six domains of surgical technical competence are scored on a 1 to 5 Likert scale, with explicit descriptions at point 1,3 and 5. Originally, the OSATS had been designed to rate surgical skills in skills laboratories. In the Netherlands, this evaluation method has largely been implemented for assessment purposes in the OR.

During a 27-months investigation period, each resident that consecutively started the clinical rotation in gynaecological surgery was asked to participate in the study. They were instructed to ask the consultant, who was scheduled as supervisor in the operation room, for an assessment with an OSATS after every procedure that they performed as a primary surgeon during this period. Procedures during which a resident independently performed some important steps were included for assessment as well. Supervisors were instructed to fill out the OSATS form by rating the performance on each domain, irrespective of the resident's training level.

Data were analysed using SPSS for Windows (SPSS version 16.0 SPSS Inc., Chicago, IL). The total score of each OSATS was calculated by adding up the score of the six domains (at minimum 6 and maximally 30 points). Learning curves were drawn by plotting resident's OSATS scores against his/her procedure-specific experience, in which the experience was quantified by the surgical caseload (one number was added to the caseload for each consecutive procedure that had been rated with an OSATS). The curve for the mean OSATS score per caseload was plotted to approximate the general learning curves for MIS and conventional surgery. To study the relation between OSATS score and caseload for the different surgical techniques, linear mixed models (LMM) were used. These models were fitted as a random coefficients model - a random slope and a random intercept - for resident and a fixed effect for the type of procedure. P-values <.05 were considered statistically significant. Ninety-five per cent confidence intervals (95%CI) were calculated.

RESULTS

All nine residents who attended their three months clinical rotation in gynaecological surgery during the investigated period agreed to participate in the study. Although no exact data of all participants was available, their prior experience was limited to about ten autonomously performed caesarean section, and some diagnostic laparoscopies or the removal of an ectopic pregnancy. In general, they had not performed elective surgery yet, and therefore no experience with vaginal or hysteroscopic procedures. Obviously, inter-individual variations would have been present.

A total of 319 surgical procedures were assessed; 129 OSATS for MIS and 190 OSATS for conventional surgery, 40 and 60% respectively (Table 1). Regarding MIS, 98 laparoscopic and 31 hysteroscopic procedures were assessed. The majority of the laparoscopic procedures included removal of an adnex, cystectomy, diagnostic laparoscopy and tubal sterilization. The hysteroscopic procedures were diagnostic and therapeutic, in which the latter mainly concerned resections of polyps and myomas type 0. The conventional procedures were either performed using an abdominal (n=125), or a vaginal approach (n=65). Conventional procedures were, next to caesarean sections, mainly abdominal and vaginal hysterectomies. An individual resident obtained a median of 40 assessed procedures (range 12-60), of which 13 procedures were minimally invasive (range 2-26).

Table 1. Characteristics of learning curves MIS and conventional surgery.

Category of procedures	Number of assessed procedures	Learning curve characteristic	
		Intercept (95%CI)	Slope (95%CI)
MIS procedures	**129**	**17.2 (15.3-19.2)**	**1.77 (1.19-2.35)**
Laparoscopic procedures	98	18.9 (16.7-21.2)	1.40 (0.16-2.63)
Hysteroscopic procedures	31	12.9 (9.5-16.3)	2.69 (1.45-3.94)
Conventional open procedures	**190**	**21.5 (19.6-23.3)**	**0.75 (0.15-1.35)**
Abdominal approach	125	21.5 (19.0-24.0)	0.69 (0.18-1.20)
Vaginal approach	65	21.7 (19.1-24.3)	0.47 (-0.05-1.00)

The supervising consultants were 21 gynaecologists. Some of them were obstetricians who only supervised obstetric procedures like caesarean sections, while others were experts in minimally invasive surgery who also supervised conventional surgical procedures.

The total OSATS scores were plotted against a resident's procedure-specific experience for the first ten procedures. Additionally, the average MIS OSATS score and conventional OSATS score were calculated for each caseload (1 to10). The resulting two curves can be interpreted as an approximation of the general learning curves for both surgical techniques (Figure 1).

The average OSATS score plotted against procedure-specific experience. MIS = Minimally invasive surgery (laparoscopy/hysteroscopy); conventional surgery = open abdominal/vaginal procedures.

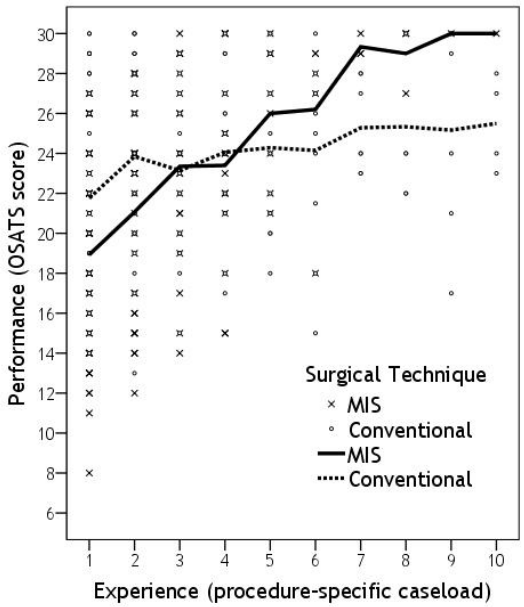

Figure 1. Learning curves for MIS and conventional surgery.

LMM analysis revealed that the slopes of the learning curves, i.e. the average increase in OSATS score for each consecutively assessed procedure, differed significantly for MIS versus conventional surgery, 1.77 versus 0.75 points per procedure (95%CI: 1.19-2.35 versus 0.15-1.35, p<.01). Table 1 shows the slopes as well as the intercepts resulting from the LMM analyses.

DISCUSSION

Residents in Ob/Gyn progress at least as fast along the learning curve for MIS as along the curve for conventional procedures during an intensive three-months clinical rotation in gynaecological surgery. This finding is in contrast with the often heard, but never scientifically supported, concern that surgeons have to proceed along a longer learning curve to acquire these MIS skills.

Concerns about how to acquire these complex skills should be considered in the context of the explosive growth of the MIS technique. In a relatively short time this approach has evolved to be the 'gold standard' for many disorders, like ectopic pregnancies and benign ovarian tumours.[Clasen et al., 1997; Medeiros et al., 2008] However, after the initial reports of success of MIS, doubts surfaced regarding its safety.[Aggarwal et al., 2004] A factor possibly contributing to these doubts is that the surgeons, although experienced in conventional surgery, often had to acquire the MIS skills in an autodidactic way. At these times, neither structured training programs, nor simulators were available to train their skills. Under those circumstances, it was probably hard to transfer the skills which they had just acquired themselves to the residents in training. This factor certainly has contributed to the slow implementation of MIS techniques, as observed in the Netherlands.[Kolkman et al., 2006]

For this study, we choose to classify both laparoscopy and hysteroscopy as MIS. Even though these surgical techniques are different, they require common psychomotor skills, like manipulation of long surgical instruments while looking to a video screen and interpretation of a three-dimensional operation field from a two-dimensional display.

For interpreting the faster advancing of residents along the MIS learning curve than along the curve for conventional procedures four factors need to be taken into account: the resident seniority, a structured curriculum, their audio-visual dexterity, and the mentor proficiency. In the first place, they all were PGY 4 residents, and already had gained some operative experience in their preceding three years of residency. On call, residents were equally exposed to conventional open surgery, e.g. caesarean sections, as to MIS, like a diagnostic laparoscopy or laparoscopy for an ectopic pregnancy. This implies that conventional surgery is as 'conventional' to them as MIS. Secondly, they all had been exposed to simulator training focusing on MIS, because they all had attended the uniform, mandatory Dutch basic skills course during the first two years of residency.[Hiemstra E et al., 2008] During that course, they attended theoretical sessions and received hands-on training on validated endoscopic trainers. Technical skills acquired on validated simulation devices have proven to be transferable to the OR setting. [Anastakis et al., 1999; Hyltander et al., 2002] In the third place, this younger generation of residents has, at average, experienced an earlier introduction to computers and other audio-visual devices. This will thin the technical interface between surgeons and screen-mediated medical applications, like hysteroscopy and laparoscopy.[Rosser, Jr. et al., 2007] This may have led to an easier acquisition of MIS skills for current generation of residents. Finally, the teachers of the MIS procedures will have played an important role. Currently, they may be better able to transfer their skills to the next generation compared to a decade ago when they were still progressing along their own learning curve.

The diversity of the study population is inherently to the clinical research that was performed. The nine participants considerably varied with respect to the number of conventional and laparoscopic procedures they had performed prior to inclusion in the study. Furthermore, their manual dexterity, their eagerness to acquire surgical skills varied and to collect OSATS forms was not consistent. This can be taken as a limitation of the study. However, as in daily practice all these influences were allowed to colour the results, this study generates unique and actual information about clinical practice when compared to data collected in laboratory settings.

However, it has to be considered that the residents' palette of MIS surgery mainly consisted of adnexectomies and cystectomies, while the majority of the conventional procedures were caesarean sections and hysterectomies, performed either abdominally or vaginally. Obviously, the two categories of procedures are not equivalent. Intuitively, these MIS procedures are less complex than the conventional procedures. To our knowledge, no system is available to compare the complexity of all these procedures. However, the European Society of Gynaecological Endoscopy (ESGE) classified laparoscopic procedures, and a cystectomy and an adnexectomy are less complex procedures than the laparoscopic hysterectomy (respectively level 2 and 3).[ESGE 2009] Nevertheless, it is promising to observe that the basic MIS procedures are not difficult to learn within a three-months clinical rotation. Hopefully, this will result in a speedier implementation of the MIS technique by the next generation of gynaecologists.

Assessment of surgical skills is a very important and contemporary concern for all teachers in surgical professions.[Chen et al., 2010; Sweet et al., 2010] Although OSATS have been designed to assess skills objectively, an assessment by an individual person is by definition not free of subjectivity. Therefore, the objectivity of OSATS to measure learning curves may be criticized. Though, in absence of a gold standard to assess OR performance, it may be the best tool currently available. At least, it has proven to be superior to a task specific checklist and a pass/fail judgement,[Martin et al., 1997] and it surely is less subjective than a general assessment at the end of a rotation on a recall basis. Furthermore, other measures to monitor the learning process like the duration of the procedure and the complication rate do not seem that useful during residency because these largely depend on the supervisor. In fact, it is questionable whether these measures reflect a surgeon's skilfulness at all, being influenced by the selection of the patients.

The OSATS-based learning curves of PGY 4 residents during three-months clinical rotations form an important first step to gain insight in residents' learning process in the OR setting. The results indicate that basic MIS procedures are not harder to acquire during residency than conventional surgical procedures. Moreover, as the current residency program rather well facilitates the acquiring of basic MIS procedures, residents are provided with a solid foundation to progress to the more advanced MIS procedures after residency.