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TRAINING IN LAPAROSCOPIC SURGERY: FROM THE LAB TO THE OR

POUČEVANJE LAPOROSKOPSKE KIRURGIJE: IZ LABORATORIJA V OPERACIJSKO DVORANO

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Review article
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Abstract

Training in laparoscopic gynaecological surgery is challenged by the boundaries of the traditional apprentice-tutor model and the ethical objective of limiting the complication rates. The European Academy for Gynaecological Surgery (The Academy) has focussed their scientific work in the last 6 years on defining the standards a future laparoscopist must meet in order to operate, either independently or under supervision.

The Laparoscopic Skills Testing and Training (LASTT) model has been proved feasible and to have face and construct validity. Furthermore, it has been proved in this model that basic laparoscopic psychomotor skills (LPS) require proper training and that proficiency in those skills cannot be acquired by only training more complex tasks, such as intra-corporeal knotting. The observation that the LPS are retained over long periods is very important for the structure of a training program, being therefore comparable to swimming or biking skills. The data gathered over these years by the Academy, and supported by reports from other groups, strongly recommend that an in-house in vitro model for training and testing laparoscopic skills should be available in every teaching centre. Only those who reach proficiency in these practical skills, and who demonstrate sufficient theoretical knowledge, will have access to the "Green Card" that defines the minimum requirements prior to training for surgical procedures with patients. Following this strategy, we postulate that the morbidity and mortality rate associated with laparoscopic procedures in training centres will be reduced and the efficiency of one-to-one teaching will be improved.

Key words: laparoscopy, training, education, laparoscopic psychomotor skills, The European Academy of Gynaecological Surgery, hand-eye coordination, laparoscopic camera navigation, bimanual coordination, laparoscopic intra-corporeal knot tying, face validity, construct validity, retention of skills

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Izvleček

Iz*popolnjevanje v spretnosti endoskopske ginekološke kirurgije vodijo meje, ki jih postavlja model tradicionalnega odnosa vajenec-mojster ter etični cilj operirati s čim manj zapletov. Evropska akademija za ginekološko kirurgijo (The Academy) je zadnjih 6 let svoje znanstveno delo osredotočila na definiranje standardov, ki jih mora izpolnjevati bodoči laparoskopski kirurg, da bo lahko operiral samostojno ali pod nadzorom.*

Model LASTT (The Laparoscopic Skills Testing and Training) je pokazal, da je izvedljiv, da ima realno vrednost in da pokaže tudi na razlike med različno sposobnimi operaterji. Z modelom je bilo tudi dokazano, da je za osnovne laparoskopske psihomotorične veščine (LPS) treba vaditi in da se do izvrstnosti v teh veščinah ne da priti z vadbo bolj zapletenih veščin kot je intra-korporealno vezanje vozlov. Izjemno pomembna za strukturo tečajev vadb je ugotovitev, da LPS znanje zadržimo dolgo časa, kar lahko primerjamo z obvladovanjem veščin kot sta vožnja kolesa ali plavanja. Podatki, ki jih je v zadnjih letih zbrala The Academy in jih podpirajo rezultati drugih skupin, zelo priporočajo, da ima vsak center za poučevanje svoj model za vadbo in testiranje laparoskopskih veščin. Le tisti, ki bodo dokazali, da so vešči v praktičnih veščinah in bodo pokazali dovolj teoretičnega znanja, bodo imeli dostop do »Zelene karte«, ki definira minimalne zahteve pred začetkom operiranja bolnikov. Naš postulat je, da če sledimo tej

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strategiji, se bo obolevnost in smrtnost po laparoskopskih operacijah v centrih za edukacijo zmanjšala in učinkovitost učenja eden-na-enega izboljšala.

Ključne besede: laporoskopija, poučevanje, izobraževanje, laparoskopske psihomotorične veščine, Evropska akademija ginekološkega operiranja, koordinacija roki-oči, upravljanje laparoskopske kamere, bimanualna koordinacija, intra-korporealno laparoskopsko vezanje vozlov, zunanja veljavnost, konstruktna veljavnost, ohranjanje veščin

1 INTRODUCTION

Minimally invasive surgical techniques are progressively replacing conventional open techniques. Laparoscopy, in both its conventional form and in its recently developed modalities, it is clearly associated with better cosmetic results, shorter hospitalization, less postoperative pain and faster labour reinsertion. Furthermore, laparoscopy allows new approaches otherwise impossible using laparotomy.

Although anatomy visualization has been strongly improved, laparoscopic techniques might be related to increased patient morbidity and mortality if not properly performed. To ensure patient safety, a future laparoscopist should possess objectively measurable theoretical and practical skills, which is not yet assessed in a standardised and universal way.

In addition to the surgical skills required for open surgery (manual dexterity and a knowledge of anatomy, pathology and surgical techniques), laparoscopy also demands specific laparoscopic psychomotor skills (LPS) since the surgeon needs to work in a key-hole environment. Under these circumstances, tactile feedback, three-dimensional vision and freedom to move hands and instruments are missing. Indeed, laparoscopy demands an ability of depth appreciation on a two-dimensional screen, hand-eye coordination, bimanual coordination, ambidexterity and handling long instruments from a fixed position. Furthermore, counter-intuitive movements of the hands (fulcrum effect) are required, normal hand tremor is amplified at the tip of a long instrument, and the visual field not only becomes two-dimensional but also unstable because the camera is normally navigated by a less experienced surgeon.

The major limitation for the more universal and faster application of laparoscopic techniques worldwide is the excessively long learning curves reported due to the lack of sufficient laparoscopic skills. Since this is clearly associated with a higher intra-operative complications rate, laparoscopy is not seen by many people as real minimally invasive surgery.

In the same manner as conventional surgery, the effective acquisition of both general surgical skills and specific LPS can only be accomplished with appropriate training. Historically, the apprentice-tutor model has been used for years as the paradigm of training in surgery. In this model, the apprentice first observes, then helps and finally operates under guidance in the operating room (OR). Achieving proficiency in both general surgical skills and specific LPS using this model seems not only impossible but also ethically unacceptable, due to the increased operating time and higher complication rate. Furthermore, the limited number of tutors available and long learning curves reported (the large amount of procedures needed to achieved proficiency) [1-4] makes this model unsuitable as the only method for training in laparoscopic surgery. This issue is especially relevant for gynaecological surgery because residents are exposed to fewer and fewer surgical cases in their daily practice.

Due to these limitations, specialists in medical education agree that part of the training has to take place outside the OR, and various animal and artificial models have been proposed. Animal models seem ideal because they imitate the human clinical scenario in a very realistic way (e.g., pulsating vessels, pneumoperitoneum, etc.) [5-7]. They are normally used for short periods (e.g. 2-3 days) in specialized training centres during training courses that simulate the classic apprentice-tutor model (i.e., surgery in the OR under tutor guidance). However, these models are not used for longer periods or in a routine and systematic basis in teaching hospitals due to financial and ethical restrictions. Indeed, the most commonly used animal model (i.e., the pig) requires a sophisticated anaesthetic machine and the permanent presence of an anaesthesiologist, a tutor and an assistant, making the model very expensive for longer training periods. In an attempt to counteract some of limitations of the pig, we have developed the rabbit nephrectomy model, which has been demonstrated as suitable for training for longer periods. This has allowed us to be able to evaluate the learning curves of individuals and to detect differences between groups with different levels of experience in laparoscopic surgery [8, 9].

A large variety of artificial models have been developed including various types of trainer boxes and virtual reality models. In contrast to animal models, these inanimate models have the advantage of allowing longer training periods, which is crucial for ensuring full LPS acquisition and not only exposure to specific laparoscopic tasks. Both trainer boxes and virtual reality models allow relaxed and controlled training, and learning curves for different laparoscopic tasks have been reported [10-12]. Trainer boxes are relatively cheap and accessible [13], whereas virtual reality models provide an objective evaluation of the learning process [14], with both being equally effective for acquiring laparoscopic skills [15].
In spite of the promising data available about the evaluation and training of laparoscopic skills [16-20], validated and well-structured programs including pre-clinical training are not universally implemented. The ideal model must be feasible, reproducible, reliable and validated for its realism (face validity), its appropriateness as a teaching tool (content validity), its capacity to distinguish between different levels of experience (construct validity), its capacity to correlate with the gold-standard of the moment (concurrent validity), and also its capacity to predict future performance (predictive validity).

2 THE ACADEMY PROJECT

The European Academy of Gynaecological Surgery (Academy) aims to offer the gynaecological community scientifically validated standards and criteria for training and education in gynaecological endoscopy and to establish certified training programmes for residents and postgraduates.
The Academy's mission for the creation and organization of training seminars is:

1. To provide education and training for gynaecologists in performing laparoscopic surgery based on the best possible scientific evidence;
2. To provide guidelines for these training courses, standards of practice and the granting of privileges that promote patient safety and the best clinical outcome;
3. To define and provide tools and guidelines for measurement in assessing laparoscopic psychomotor skills;
4. To certify a gynaecologist's expertise and progress in laparoscopic psychomotor skills;
5. To measure, on an on-going basis, the quality and effectiveness of the Academy's educational programmes and to adapt them based on the results obtained;
6. To serve as a forum for ideas and the exchange of information on current and emerging training methods;
7. To foster, support and encourage scientific research on training for gynaecological surgery.

2.1 The Laparoscopic Skills Testing and Training (LASTT) Model

Within this general aim, The Academy has recently developed a trainer box (the LASTT model) that aims to specifically train and measure certain LPS [21]. This box contains the LASTT model, which is a wooden model representing the planes and angles of a female pelvis. The exercise accessories include inserts with letters and characters and colour pins and rings. A comprehensive interactive DVD, including video chapters teaching the different exercises for the proper execution of LASTT exercises is implemented together with a printed manual, a stopwatch and the required profile and scoring forms.
Each box contains the necessary tools to be able to test individuals for their proficiency. Web access to the Academy central data repository is provided, giving the possibility of immediate feedback and test results. The LASTT model with the relevant materials for the various exercises is introduced into the Szabo trainer box (Karl Storz, Tutlingen, Germany). The exercises are performed using standard instruments (10mm 0º/30º optic, 5mm Kelly dissection forceps and Matkowitz grasping forceps) and the optic is connected to an all-in-one (monitor, light source and video-camera) laparoscopic tower (Telepack, Karl Storz, Tutlingen, Germany).

2.2 The Laparoscopic Tasks

Laparoscopic camera navigation, hand-eye coordination and bimanual coordination are the specific LPS aimed to be trained and measured using the LASTT model [22].

- **Laparoscopic Camera Navigation (LCN):** This task aims to evaluate the ability to navigate a laparoscopic camera with a 30º optic. This is done by measuring the ability to identify 14 different targets placed at different sites in the LASTT model. Each target includes a large symbol only identifiable from a panoramic viewpoint and a small symbol only identifiable from a close up viewpoint. The task starts by identifying the large symbol on the first target (i.e. 1) and then the small symbol situated next to it, which must be shown on the centre of the screen. This small symbol indicates the next large symbol to be identified. Following this order, the participant continues until the identification of the small symbol on the last target (i.e. end).

- **Hand-Eye Coordination (HEC):** This task aims to evaluate the ability to navigate a laparoscopic camera with a 0º optic with the non-dominant hand (NDH) and to handle laparoscopic forceps with the dominant hand (DH). This is done by measuring the ability to grasp and transport six pre-defined objects to six pre-defined targets in the LASTT model, which is fitted with coloured objects (5 x 4 mm open cylinders) and coloured targets (10 x 1 mm nails). The matched targets and objects are identifiable by colour. The exercise starts by identifying a target and an object of the same colour. The object is then grasped, transported and introduced onto the relevant nail. Only when the participant has succeeded in introducing the cylinder into the matching nail is he/she allowed to continue with the next object.
- **Bimanual Coordination (BMC):** This task aims to evaluate the ability to handle laparoscopic forceps simultaneously with the DH and NDH. This is done by measuring the participant's ability to grasp six pre-defined objects with the DH and re-grasp and transport them with the NDH to six pre-defined targets on the LASTT model, which is fitted with coloured objects (10 x 5 mm push pins with a tail of 10 mm) and coloured targets (20 mm holes). The matched targets and objects are identifiable by colour. The exercise starts by identifying a target and an object of the same colour. Then the push pin is grasped by the head with the Matkowitz forceps (DH) and passed to the Kelly forceps (NDH), with which it is re-grasped by the tail, transported and introduced into its target. Only when the participant succeeds in introducing an object into its target, is he/she allowed to continue with the others.

The scoring system used for each task was the subject of evaluation and after some trials, the Time to Correctly Performed Exercise (TCPE) was chosen. This system reflects errors and economy of movement in the results and thus engages an accuracy assurance. For each repetition, the time was limited to 120 seconds for LCN and 180 seconds for HEC and BMC. In each repetition, the numbers of objectives actually achieved were recorded (i.e. targets identified for LCN and objects transported for HEC and BMC). When any objectives were accomplished, a value of 0.5 was assigned. Since some participants may not complete the task in the assigned time, the final score was obtained by dividing the actual time taken by the number of objectives effectively accomplished [22].

3 FACE VALIDITY

Face validity evaluates the realism of the model for the purposes proposed by its developers. This was assessed in a substantial study comprising residents and specialists in OB&GYN (n=199) attending workshops organized by the Academy during the 20th European Congress on Obstetrics and Gynaecology (EBCOG) in Lisbon, Portugal in 2008 (n=56), the 24th Annual Meeting of the European Society of Human Reproduction and Embryology (ESHRE) in Barcelona, Spain in 2008 (n=58), the Workshop on Laparoscopic Hysterectomy in Tuebingen, Germany in 2008 (n=24), the Laparoscopic Suturing Course in Leuven, Belgium in 2009 (n=7), the 19th European Meeting of the European Network for Trainees in Obstetrics and Gynaecology (ENTOG) in Budapest, Hungry in 2009 (n=12), and the 30th Congress of the Spanish Society of Gynaecology and Obstetrics (SEGO) in Barcelona, Spain in 2009 (n=42) [23].

Participants were asked to self-report their previous experience in laparoscopic surgery, taking into account the type of procedures already performed (based on the European Society for Gynaecological Endoscopy (ESGE) classification [21]) and in the actual number of procedures performed for each category. According to this system, they were classified in three different groups (G). G1 comprises those with no or very little exposure to laparoscopy. G2 comprises those with limited exposure to laparoscopy. G3 comprises those with significant exposure to laparoscopy [23].

After being exposed to the model and performing the three laparoscopic tasks consecutively, the participants were asked to respond to a questionnaire with 11 questions (Q) (Table 1) using a 10 cm visual analogue scale (VAS) (0: not realistic/good/useful; 10: very realistic/good/useful). Q1-Q8 examined the usefulness of the different tasks and of the overall model in terms of testing and training capacities for LPS. Q9-Q11 examined the usefulness of the model in terms of its realism and relevance to laparoscopic surgery.

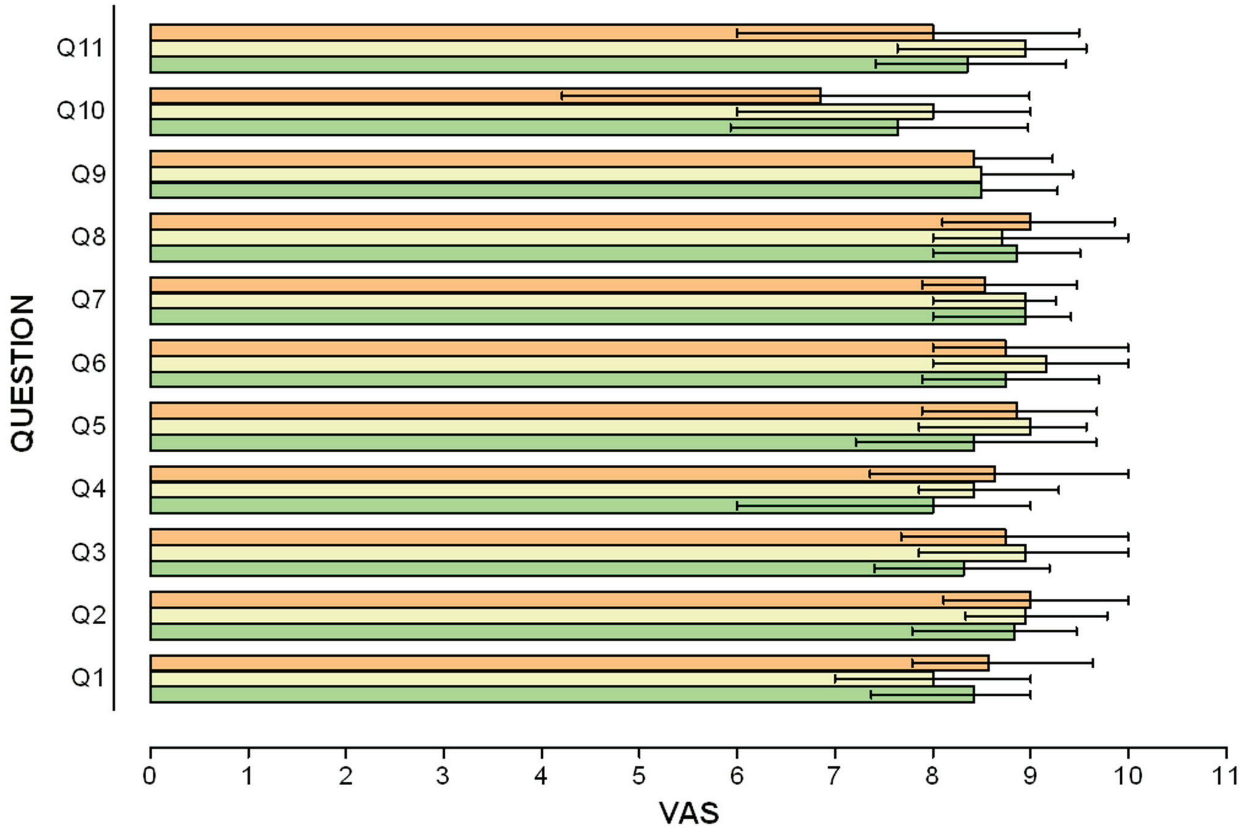
Table 1. Questionnaire to test the face validity of the model and the exercises.
Tabela 1. Vprašalnik za preverjanje zunanje veljavnosti modela in vaj.

Questions **Vprašanja**	**Score** (n=192) **Ocena**
The face validity of the model for testing and training LPS **Zunanja veljavnost modela za testiranje in vežbanje LPS**	
Q1. Ability to test camera navigation Zmožnost, da testira navigacijo kamere	8.4 (7.6 – 9.1)
Q2. Ability to train camera navigation Zmožnost, da vadi navigacijo kamere	9.0 (8.0 – 9.8)
Q3. Ability to test hand-eye coordination Zmožnost, da testira koordinacijo rok-oči	8.6 (7.6 – 9.6)
Q4. Ability to train hand-eye coordination Zmožnost, da vadi koordinacijo rok-oči	8.4 (7.0 – 9.5)
Q5. Ability to test bimanual coordination Zmožnost, da testira bimanualno koordinacijo	8.6 (7.7 – 9.7)
Q6. Ability to train bimanual coordination Zmožnost, da vadi bimanualno koordinacijo	9.0 (7.9 – 9.8)
Q7. Overall value of the model as a testing tool Skupna vrednost modela kot orodja za testiranje	8.8 (8.0 – 9.4)
Q8. Overall value of the model as a training tool Skupna veljavnost modela kot orodja za vajo	9.0 (8.0 – 9.8)
The face validity of the model for actual laparoscopic surgery **Zunanja veljavnost modela za resnično laparoskopsko operiranje**	
Q9. Relevance for actual laparoscopic surgery Pomembnost za resnično laparoskopsko kirurgijo	8.4 (7.2 – 9.3)
Q10. Realism in simulating the female pelvis Realistično simuliranje ženske medenice	7.3 (5.3 – 9.0)
Q11. Realism in simulating the movements required Realističnost simulacije zahtevanih gibov	8.4 (7.0 – 9.5)

The median (interquartile range) scores of a 10cm VAS (0: not realistic/good/useful; 10: very realistic/good/useful) are presented. Modified and reproduced with permission from Gynecol Surg 2010; 7: 133-141.

One hundred and two participants effectively completed the test and gave a favourable response to this model. Similar responses were observed in the three groups analysed separately (Figure 1). The first six questions (Q1-Q6), in which the individual exercises were evaluated in terms of their testing and training capacities, were well validated by all the participants, all receiving a score above eight. This evaluation of the individual exercises was reflected in the overall assessment of the model. Indeed, all the participants considered that the model was good for testing (Q7) and for training (Q8) purposes. The relevance of the model for actual laparoscopic surgery (Q9) and to simulate the movements required to perform laparoscopic surgery in the pelvis (Q11) were judged positively. However, its realism in simulating the female pelvis (Q10) received the lowest validation.

Figure 1. The Face Validity of the LASTT Model.
Slika 1. Zunanja veljavnost modela LASTT.



The median (interquartile range) scores of the questionnaire assessing the face validity of the LASTT model using a 10cm VAS (0: not realistic/good/useful; 10: very realistic/good/useful). Participants were grouped according to their level of exposure to laparoscopic surgery in three groups: G1 (no or little exposure, green bars), G2 (intermediate exposure, yellow bars) and G3 (significant exposure, orange bars). Reproduced with permission from Gynecol Surg 2010; 7: 133-141.

4 CONSTRUCT VALIDITY

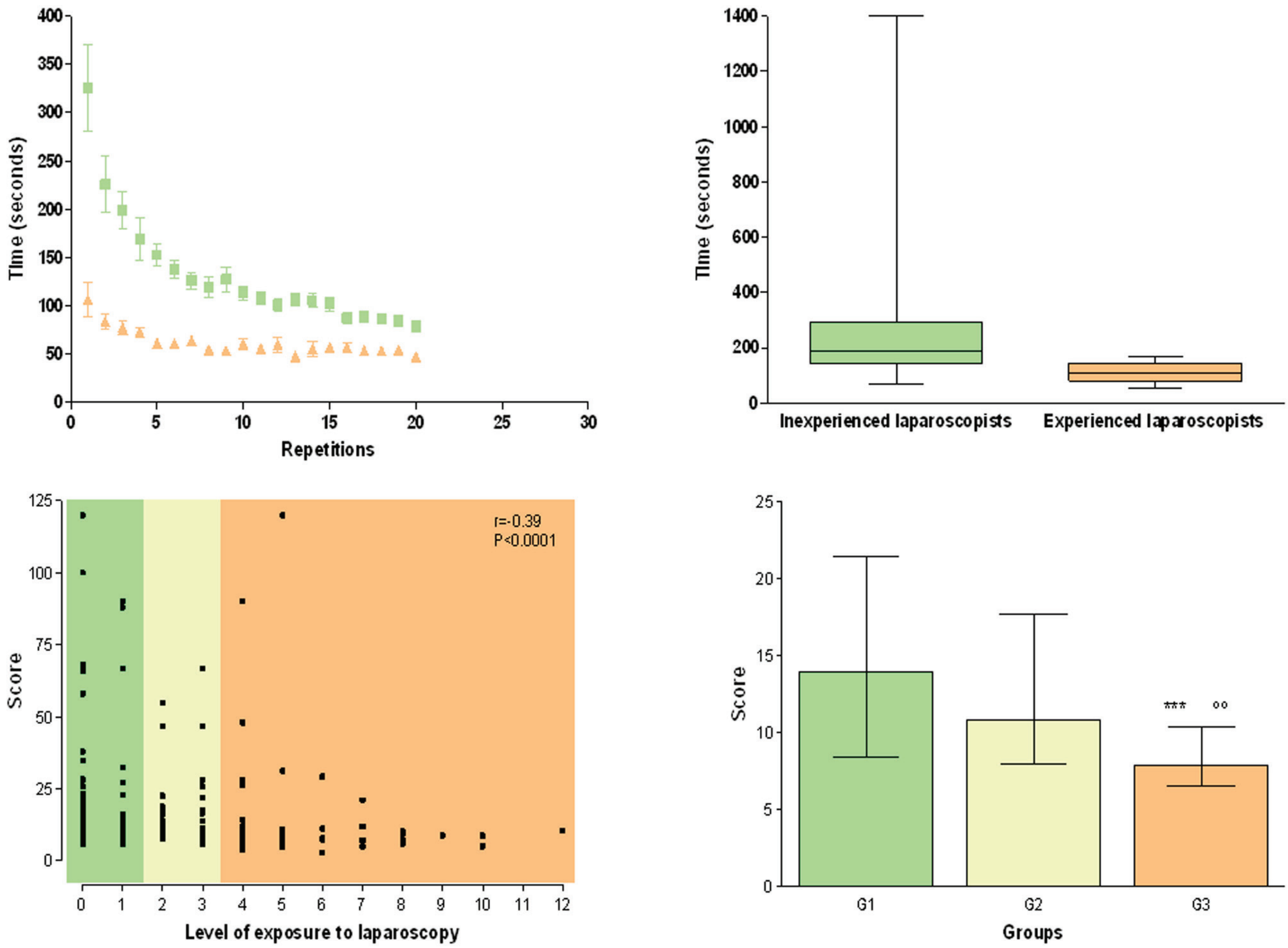
In a surgical model, the construct validity evaluates the capacity of the model to differentiate between surgeons with different levels of experience. This was first assessed in a pilot study (study 1) performed in 2005 at the Centre for Surgical Technologies of the Katholieke Universiteit Leuven (Leuven, Belgium) and at the ENDOVISION European School of Endoscopy (Villach, Austria) by novices (students and gynaecologists with no or little experience in laparoscopy; n=14)) and experts (gynaecologists with proven experience in this discipline; n=10). Laparoscopic skills were measured throughout up to 30 repetitions for LCN, HEC and BMC, which were performed in chronological order, allowing the evaluation of the learning curves and of the construct validity of the tasks [21].

To confirm and enlarge the data, construct validity was then evaluated in a second larger study (study 2) performed by residents and certified gynaecologists with various levels of experience in laparoscopic surgery (n=283) during Skills Evaluation Workshops of the Academy during the following meetings: Workshop at the Leuven Institute for Fertility and Embryology (LIFE) in Leuven, Belgium in 2005 (n=17), the 19th European Congress on Obstetrics and Gynaecology of the EBCOG in Torino, Italy in 2006 (n=44), the 1st Congress on Gynaecology and Obstetrics MERCOSUR 2006 in Asunción, Paraguay in 2006 (n=158), the 3rd Portuguese Congress of Reproductive Medicine in Porto, Portugal in 2007 (n=36) and the Advance Course on Gynaecological Laparoscopic Surgery at the European Institution of TeleSurgery (IRCAD/EITS) in Strasbourg, France in 2007 (n=28). Participants were classified as novices (n=241) or experts (n=42) based on a self-reported questionnaire reporting the number of procedures already performed using the ESGE classification. They were considered novices when they had not yet performed any laparoscopy or had performed only basic procedures, regardless of the number of procedures performed. They were considered experts when, in addition to any basic procedures, they had performed at least 30 intermediate and/or advanced procedures. Those who could not be allocated to one of the two groups were excluded from the study. All the participants performed three consecutive repetitions of each task. The individual average values of the triplicate observations were used for statistical analysis [21].

These first two studies were carried out using a scoring system different from the one currently used. Since interim analysis demonstrated the advantages of a modified and unified scoring system for the different tasks, construct validity was evaluated again in the large study mentioned above (study 3) in which face validity was also evaluated and where the level of experience in laparoscopy was better discriminated [23].

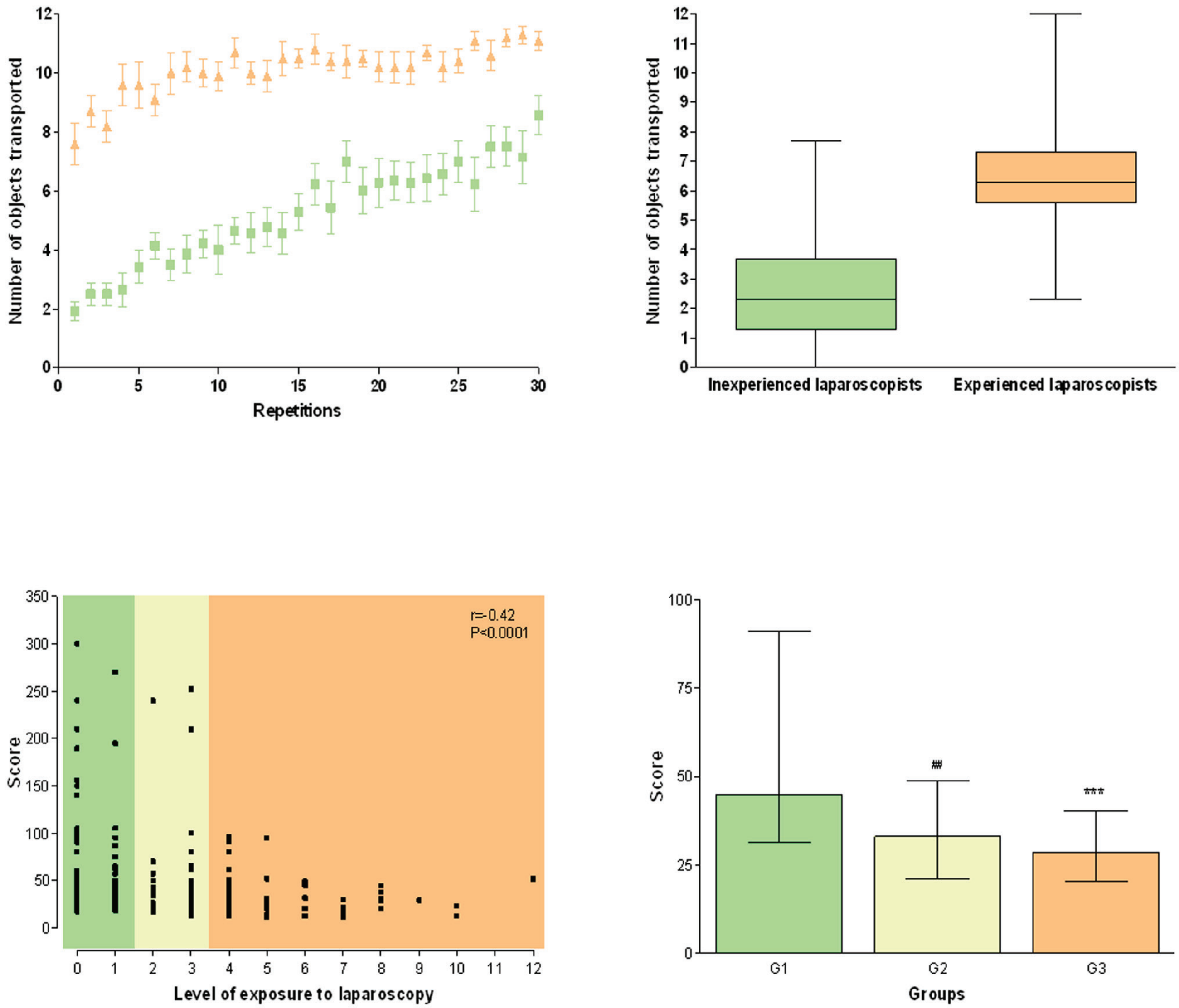
In Study 1, at the beginning of the study, experts performed much better than novices for all tasks (i.e., LCN, HEC and BMC). Both novices and experts improved their scores with consecutive repetitions, with the level of improvement being more significant in novices. At the end of the study, the experts' scores remained better than the novices' scores (Figures 2, 3 and 4) [21].

Figure 2. The construct validity of Laparoscopic Camera Navigation using the LASTT model.
Slika 2. Konstruktna veljavnost laparoskopske navigacije kamere v modelu LASTT.



The ability to navigate a laparoscopic camera with a 30º optic was evaluated by measuring the ability to identify 14 different targets placed at different sites in the LASTT model. In Study 1 and 2, participants were classified as novices (green) or experts (orange) and the time required for identifying all the targets was recorded. In Study 3, the left graph shows the participants´ scores as a function of their exposure to laparoscopy. The right graph shows the scores of G1 (no or little exposure; green), G2 (intermediate exposure; yellow) and G3 (significant exposure; orange). Reproduced with permission from Gynecol Surg 2010; 7 (2):133-141 and from Gynecol Surg 2008; 5: 281-290.

Figure 3. The construct validity of Hand-Eye Coordination using the LASTT model.
Slika 3. Konstruktna veljavnost koordinacije roki-oči v modelu LASTT.



The ability to navigate a laparoscopic camera with a 0º optic with the NDH and to handle laparoscopic forceps with the DH was evaluated by measuring the ability to grasp and introduce six objects into six targets in the LASTT model. In Study 1 and Study 2, the participants were classified as novices (green) or experts (orange) and the numbers of objects transported in two minutes were recorded. In Study 3, the left graph shows the participants´ scores as a function of their exposure to laparoscopy. The right graph shows the scores of G1 (no or little exposure; green), G2 (intermediate exposure; yellow) and G3 (significant exposure; orange).
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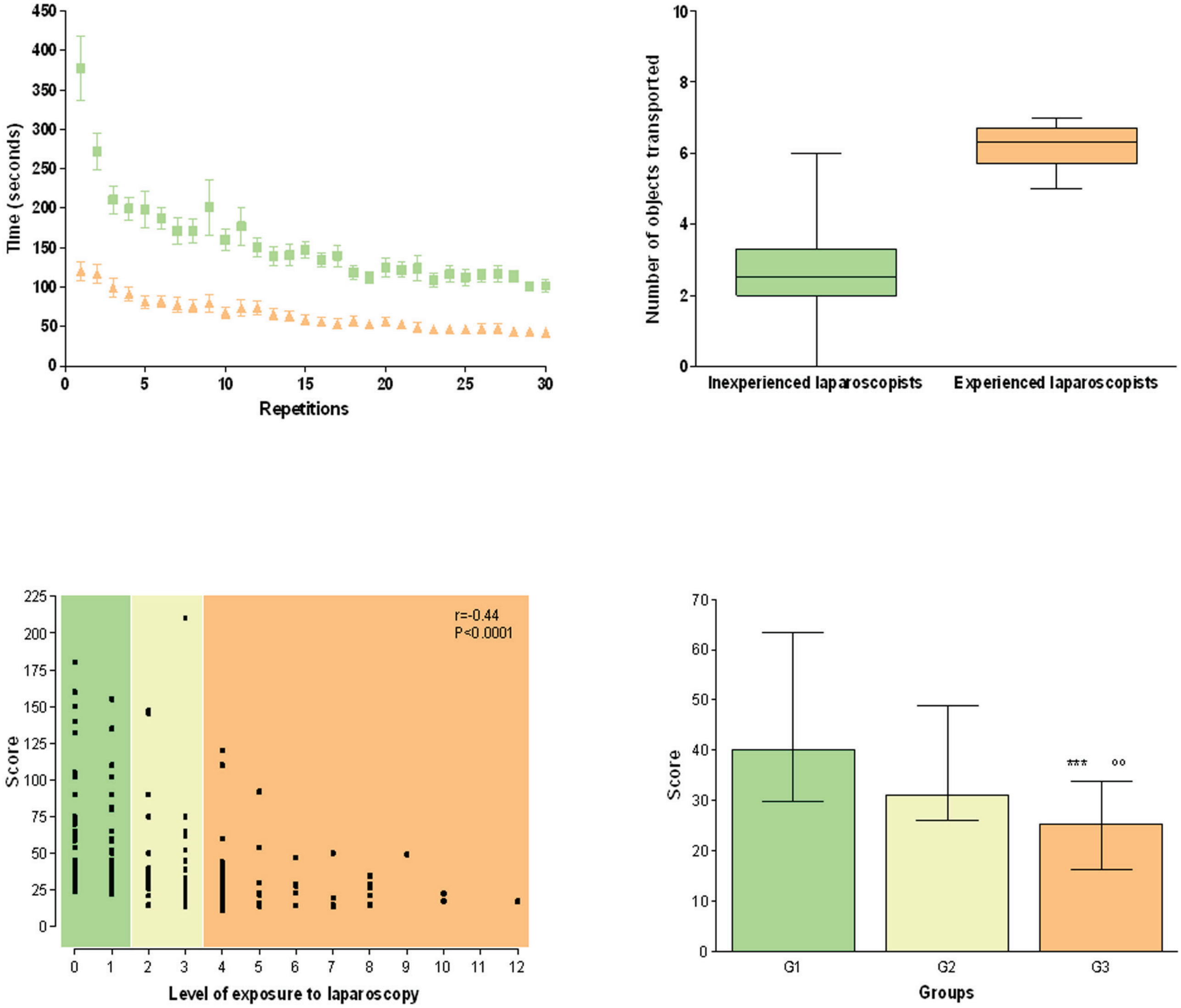
Figure 4. The construct validity of Bimanual Coordination using the LASTT model.
Slika 4. Konstruktna veljavnost bimanualne koordinacije v modelu LASTT.



The ability to handle laparoscopic forceps simultaneously with the DH and the NDH was evaluated by measuring the ability to grasp six objects with the DH and re-grasp them with the NDH and transport and introduce them into pre-defined targets in the LASTT model. In Study 1 and Study 2, the participants were classified as novices (green) or experts (orange) and the time required for transporting all the objects (Study 1) or the number of objects transported in two minutes (Study 2) were recorded. In Study 3, the left graph shows the participants´ scores as a function of their exposure to laparoscopy. The right graph shows the scores of G1 (no or little exposure; green), G2 (intermediate exposure; yellow) and G3 (significant exposure; orange). Reproduced with permission from Gynecol Surg 2010; 7: 133-141 and from Gynecol Surg 2008; 5: 281-290.

In Study 2, these differences between the novices and experts were fully confirmed for LCN (Figure 2), HEC (Figure 3) and BMC (Figure 4) [21].
In Study 3, a negative correlation between the scores and the level of exposure to laparoscopy was found for LCN (Figure 2), HEC (Figure 3) and BMC (Figure 4). Indeed, participants with significant exposure to laparoscopy (G3) scored better than those with limited exposure to laparoscopy (G2) and even better than those with no or very little exposure to laparoscopy (G1). Similarly, participants from G2 scored better than participants from G1 [23].

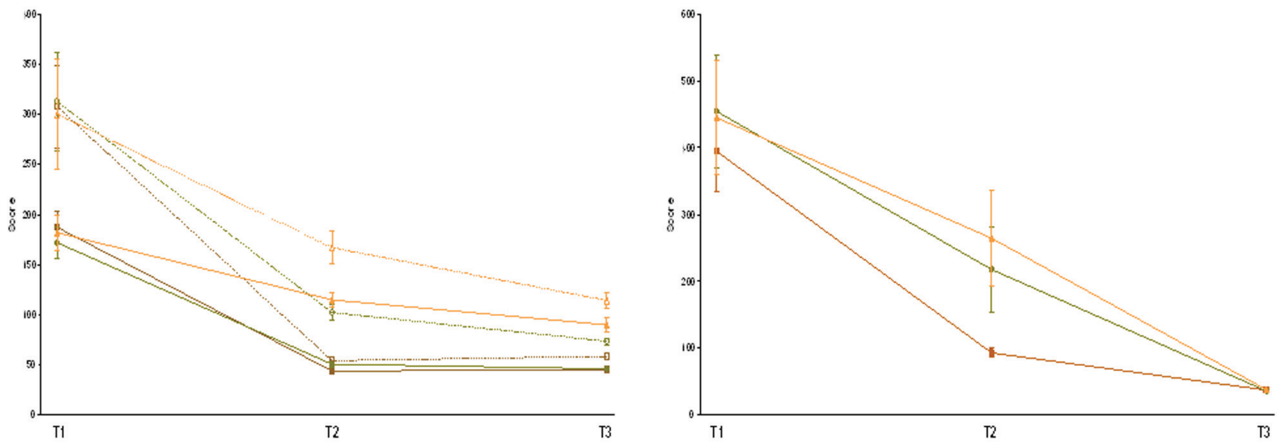
5 PREDICTIVE VALIDITY

Predictive validity evaluates the capacity of the method to predict future performance. Although in a surgical model, this eventually means the performance in a real surgical procedure on humans in the OR, we decided to evaluate the validity of the LASTT method first for more advanced laparoscopic skills, then for real surgery in animals and finally for human surgery.

We have hypothesised that mastering basic LPS will facilitate the acquisition of more advanced LPS and have conducted a study to test this logical hypothesis using 60 gynaecologists with no experience in laparoscopy. HEC was used to assess the basic LPS, while laparoscopic intra-corporeal knot tying (LICK) was used to assess advanced LPS [22].

HEC was performed and scored as described above. LICK was performed using a soft pad with pre-mounted sutures using the gladiator technique and scored as described elsewhere [22]. The participants were randomly allocated to three different groups to follow different HEC training programs and similar LICK training programs. In group 1 (G1), participants performed 60 repetitions of HEC with the DH and 60 repetitions of HEC with the NDH. In group 2 (G2), participants performed 60 repetitions of HEC with the DH only. In group 3 (G3), participants did not perform any HEC training with either the DH or the NDH. Afterwards, all the participants followed a LICK training program consisting of 60 repetitions. All the participants were tested for HEC with the DH, HEC with the NDH, and LICK at the beginning of the study (T1), immediately before the LICK training (T2), and immediately after the LICK training (T3). The groups had comparable scores at T1. At T2, G1 and G2 improved their relevant HEC scores (both hands in G1, DH in G2), and the LICK scores improved according to the previous HEC training (G1 > G2 or G3, and G2 > G3). At T3, all the groups further improved their LICK scores up to the same level. The LICK training did not provide any additional improvement in HEC for G1 and G2, but it further improved HEC for G3, though not up to the same level of the other groups (Figure 5) [22].

Figure 5. The predictive validity of basic LPS upon the advanced LPS.
Slika 5. Napovedna veljavnost osnovne LPS za nadaljevalno LPS.



The participants performed different structured training programs for basic LPS (i.e., HEC) (G1 trained in both the DH and the NDH, G2 trained in DH only and G3 did not train) and similar training for advanced LPS (i.e., LICK). The skills were measured at the beginning of the study (T1), before (T2) and after (T3), the LICK training. The left side shows the HEC scores (DH: closed symbols; NDH: open symbols) and the right side the LICK retention. G1 (brown), G2 (green), G3 (orange).

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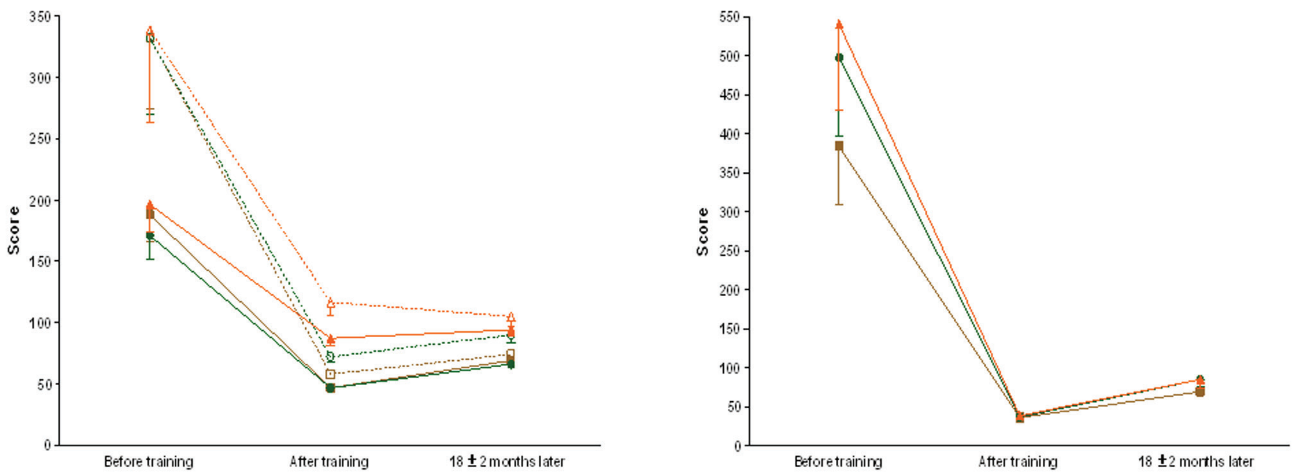
The study confirmed that training improves laparoscopic skills, indicating that many repetitions are required to reach proficiency and that the full acquisition of LPS facilitates the acquisition of more complex laparoscopic tasks.

Since mastering both skills before starting a training program in the OR seems advisable, we are performing a study to evaluate the extent that this is relevant and to assess the predictive validity of the LASTT model for live animal surgery (i.e., laparoscopic rabbit nephrectomy) in a population without any experience in laparoscopy. The preliminary data confirms the predictive validity of proper training using the LASTT model (unpublished observations). Indeed, trainees who followed a complete and structured training program for LCN, HEC, BMC and LICK are performing much better than those who did not follow this training. It is still too early to elucidate which specific task is most relevant and more importantly if both LPS (LCN, HEC and BMC) and LICK are necessary or if one of them is sufficient. In addition, to answer these questions, the study will also define the relevance of training with or without tutoring, which is crucial for both educational and administrative purposes. Furthermore, all this data will allow us to evaluate the learning curves in order to define the minimum training recommended to reach the plateau and to be able to organize the duration of training according to the program to be followed. Nevertheless, the predictive validity for real human surgery still has to be evaluated in a proper study.

6 SKILL RETENTION

In order to evaluate whether laparoscopic skills are retained differently depending on the type of training performed, we conducted a study in the same population described earlier. Eighteen months after the finalization of the structured training, and without having being exposed to any other laparoscopic procedure during this period, participants performed new tests for HEC with the DH, HEC with the NDH, and LICK. All the groups retained the skills achieved during their training programs to a large extent. Indeed, the skills observed in this study were much better than the baseline skills observed at the beginning of the structured training program, although the scores were not exactly the same at those registered at the end of that program. Interestingly, those who trained more intensively a year and a half ago retained more superior skills than those who did not follow more complete training (unpublished observations) (Figure 6).

Figure 6. Skill retention.
Slika 6. Ohranjanje veščin.



The retention of laparoscopic skills 18 months after finishing the structured training programs in which participants followed different programs for HEC (G1 trained both the DH and the NDH, G2 trained the DH only and G3 did not train) and similar training for LICK. The left side shows the HEC retention (DH: closed symbols; NDH: open symbols) and the right side the LICK retention. G1 (brown), G2 (green), G3 (orange).

7 CERTIFICATION

To counteract the diversity in strategies and regulations for training in gynaecological laparoscopy, there is an urgent need to use a validated system for credentialing an individual's skills.

The Academy in collaboration with the ESGE and EBCOG is in the final phase of defining a global program of certification for gynaecological laparoscopic surgery. The certification of an individual surgeon is based on 4 criteria, namely practical laparoscopic technical skills, theoretical skills, surgical experience and CME accreditation in laparoscopic surgical educational programs.

Laparoscopic practical technical skills can be tested using the Laparoscopic Skill Training and Testing method (LASTT®) and the Suturing Skill Training and Testing method (SUTT®). LASTT® aims to measure basic LPS, as described above. A positive test result should signal perfect laparoscopic instrument handling capabilities. The SUTT® aims to measure fine and complex motor skills by performing a correct laparoscopic stitch and a correct intra-corporeal knot. Test proficiency should result in perfect laparoscopic needle handling and intra-corporeal knotting.

The theoretical exam aims to objectively score the individual's knowledge in laparoscopic anatomy, surgical principles, instrumentation, OR functioning and complications and their management.

The scoring system for practical and theoretical skills

The results are expressed in a colour code, differentiating minimal (red) from intermediate (orange) and experienced (green) skills. Allocation to a group is based on the deviation of an individual's results in relation to a large volume of benchmark data containing the results of experienced laparoscopists. Experienced laparoscopists are defined as a group of surgeons with a high amount of laparoscopic procedures including a significant amount of surgeries of ESGE level 3 or 4.

Green Card for clinical training

In an attempt to improve the quality of clinical training in gynaecological laparoscopic surgery, the ESGE has established criteria based on the practical and theoretical knowledge of an individual to define the entry into an in OR training program: "The Green Card". The possessor of a Green Card provides the minimal practical ability in instrument handling skills and knowledge on Instrument functioning, basic anatomy and complication management that is thought necessary to enter a one to one clinical training program.

First experiences with the Green Card certification

At the recent ESGE congress in London, UK in September 2011, 32 individuals performed the theoretical and practical certification procedure. 34% of the participants reported a major exposure to laparoscopy, whereas 50% had reported an intermediate exposure and 16% a minimal exposure. Twenty seven participants (84%) proved to have sufficient practical skills and theoretical knowledge to comply with the Green Card. In a comparable certification procedure initiated in Spain with 26 first year residents in OB&GYN, it was observed that 19% of the participants have sufficient practical skills and 46% have sufficient theoretical knowledge to access the Green Card.

8 CONCLUSIONS

The current education methods for training in gynaecological surgery are being challenged by various forces and influences, such as the boundaries of the traditional apprentice-tutor model, the ethical objective of limiting patient morbidity and the error rate during laparoscopic surgical procedures and continuous pressure on the cost effectiveness of procedures (Table 2).

The increased incidence of serious (lethal) complications in common laparoscopic procedures within general surgery and gynaecology has led to major investigations by the Dutch ministry of health [24].

Training in laparoscopic techniques was found to be variable and inadequately structured. It was expressed as a matter of concern that the standards a future laparoscopist must meet in order to operate, either independently or under supervision, have not been adequately established. Seeing those challenges, it goes without saying that a structured training program in gynaecological laparoscopic surgery is necessary and should be establish objective measurable levels of competencies.

The innovative approach of the +he Academy and the ESGE lies in the fact that we have differentiated psychomotor abilities and technical skills like laparoscopic suturing from surgical skills like performing different levels of gynaecological laparoscopic procedures. Furthermore, technical skills can be validated with an objective measurable system whereas surgical activities are subject to more subjective evaluation methodologies.

Table 2. Challenges for training in gynaecological surgery.
Tabela 2. Izzivi za učenje v ginekološki kirurgiji.

The boundaries of the traditional apprentice-tutor model / Meje tradicionalnega modela vajenec-mojster
The necessity of a high volume of surgical procedures (learning curve) Potreba po velikem številu kirurških posegov (krivulja učenja)
The insufficient availability of skilled mentors Pomanjkanje veščih učiteljev
Time-consuming system Sistem zahteva veliko časa
Difficulties in the objective assessment of clinical competence at different surgical levels Težave pri objektivnem ocenjevanju klinične kompetence na različnih nivojih operiranja
The ethical objective of limiting patient morbidity and the error rate during Laparoscopic surgical procedures Etični cilji, da bi se zmanjšala obolevnost in napake pri laparoskopskih kirurških posegih
Training in laparoscopic surgical techniques is variable and inadequately structured Učenje laparoskopskih kirurških tehnik je različno in ne dovolj strukturirano
The standards that future surgeons should meet in order to operate, either independently or under supervision, are not adequately established Standardi, ki naj jih bodoči kirurgi izpolnjujejo, da bodo samostojno ali pod nadzorom operirali, niso dobro določeni
Continuous pressure on the cost effectiveness of procedures Stalen pritisk na finančno učinkovitost posegov
OR time Čas operacijske dvorane
Risk Management Obvladovanje tveganj
Cost structure for training and methods of credentialing Struktura stroškov za učenje in podeljevanje licenc
Reimbursement policy Politika vračanja izdatkov

The combined approach as proposed in the Fundamentals of Laparoscopic Surgery (LPS) program using the OSATS scoring system seems not only highly unpractical but also less objective.

The introduction of the Green Card as a license for OR activity is a major step forwards in quality control for gynaecological laparoscopic surgery. Our data shows that there is scientific evidence that significant exposure to laparoscopic surgery correlates with proficiency in instrument handling. Technical skills, like instrument handling and laparoscopic intra-corporeal suturing, are only acquired by specific training. Currently, *in vitro* training using a simple pelvi-trainer is the most appropriate method to acquire the technical skills. The online scoring platform and the simple objective scoring system make this methodology accessible to every institution responsible for resident training. Furthermore, we provide evidence that those laparoscopic technical skills last for a long period and can be compared with skills like swimming or biking. It thus seems logical and obvious, though not yet implemented, that each training centre should put an *in vitro* training station at the disposal of their residents and implement a qualification program.

OR training for laparoscopic interventions should only be accepted when the Green Card has been acquired. The Green Card defines the individual capacity to comply with those minimal theoretical and practical skills for someone who has not yet had any clinical experience in laparoscopic procedures. Defining the minimal standards using objective testing systems will increase patient safety and increase the quality of a one to one clinical training program in laparoscopic procedures.

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