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Developing a multimodal curriculum for teaching enhanced-view Total Extra-Peritoneal (eTEP)

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ABSTRACT

Background

Enhanced-view Total Extra-Peritoneal (eTEP) inguinal hernia repair is considered a technically demanding procedure with a steep learning curve

Aim: Examine the ability of residents to independently perform laparoscopic eTEP following a multimodal curriculum course.

Method: Prospective analysis of eTEP procedures performed by residents between March 2018 and September 2020. Six residents dispersed into 3 groups-group A: Two junior residents, group B: Two mid-level residents and group C: Two senior residents. The course comprised of theoretical and practical stages regarding eTEP in 5 steps. Data reviewed for each procedure included the time of each step, total time and autonomy degree as assessment for every step: 1st degree-dependent (physical assistance), 2nd degree- partially dependent (vocal assistance) and 3rd degree-independent. Early and late procedures were divided at 50% of cases.

Results: Participants performed 44 procedures (220 steps). Late procedures presented with a significant improvement in all degrees of autonomy (1st degree p=0.002, 2nd degree p=0.007 and 3rd degree p<0.0001) and in every step (Step 1 p=0.015, Step 2 p=0.006, Step 3 p<0.0001, step 4 p<0.0001, step 5 p=0.002). There was no significant difference in surgery duration between early and late procedures (p=0.32). At early procedures junior residents needed significantly higher rates of physical intervention (1st degree) compared to the senior residents (p=0.004). Conversely, there was no significant difference in 2nd degree of autonomy (p=0.46), 3rd degree (p=0.06) and surgery duration (p=0.16). The last 3 procedures performed by all participants had no significant difference between the seniority groups in autonomy (1st degree p=0.1, 2nd degree p=0.18 and 3rd degree p=0.1).

Conclusion: A multimodal curriculum course is effective in achieving competence, autonomy and confidence in performing eTEP in a short time. This method of training reduces the learning curve of laparoscopic inguinal hernia repair.

Keywords: eTEP; TEP; Laparoscopic inguinal hernia repair; Surgical training.

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INTRODUCTION

Minimally invasive surgery training has evolved through the foundations of traditional surgical education, based on a core structure of a mentor-apprentice relationship, long working hours and self-learning discipline [1,2]. Although surgical techniques have made a tremendous advancement in the last 3 decades since the introduction of minimally invasive capabilities [3-5], surgical education is advancing at a slower pace, with surgeons graduating from residency with varying degrees of competency and confidence while performing common surgical procedures [2,6-9]. Nowadays, graduating from a residency relies on reaching a pre-defined amount of cases performed, without a need to show competence, confidence, autonomy or an ability to teach the succeeding generation of surgeons. With these attributes lacking in young attending surgeons, there is a growing concern that the traditional education process in surgery is becoming outdated with the introduction of novel methods and technology. Several training models have been proven useful to teach laparoscopic surgery such as simulations, video materials, mentor presence and e-learning [10-12], but implementation of their combination has yet to be utilized in a dedicated course.

Laparoscopic Totally Extra-Peritoneal (TEP) inguinal hernia repair is considered a technical demanding procedure with a steep learning curve [13-15]. Developing a non-existent potential space, a challenging understanding of groin anatomy and a small working space with difficulty in maneuvering a large mesh into place are common struggles in performing TEP [14,15]. These challenges impede on surgical residents during training in mastering the procedure, as opposed to other common laparoscopic procedures such as laparoscopic appendectomy or laparoscopic cholecystectomy, which are performed independently early on in residency and have a relatively short learning curve. To overcome technical difficulties of TEP, Deas, et al. have proposed an enhanced-view technique for performing a totally extraperitoneal repair (eTEP) for inguinal hernias, which allows the creation of a larger work-space and a more dynamic trocar positioning by several maneuvers through a remote access to the defect.

Our aim was to implement a pilot multimodal curriculum course designed to teach eTEP to residents at different levels of experience in order to examine their ability to

perform eTEP autonomously while ensuring patient safety.

LITERATURE REVIEW

A prospective analysis of eTEP procedures performed by residents, From March 2018 to September 2020, six residents from different general surgery departments in Israel participated in the program and dispersed into 3 groups:

Group A: Two junior residents (PGY2) with minimal experience in laparoscopic and open hernia surgery.

Group B: two mid-level residents (PGY3-4) with minimal experience in laparoscopic procedures but sufficient experience in open surgery.

Group C: Two Senior/Chief Residents (PGY5) with experience in both laparoscopic and open procedures, including the trans-abdominal pre-peritoneal repair.

Data reviewed for each procedure included the time of each step, total time, degree of autonomy as assessed by the mentor for every step, intraoperative and postoperative complications. Patients with a recurrent hernia were excluded from this study. Procedures were carried out as part of the elective activity of the department during regular working hours and all cases were recorded with consent. The initial 50% of residents' procedures were referred to as early procedures and the remaining 50% were referred to as the late procedures. All patients were routinely examined in the outpatient clinic at 1 month post-op and assessed for hernia recurrence, post-operative pain, opiate analgesic use, re-admissions or emergency department visits.

An Institutional Review Board (IRB) approved the study protocol.

Technical aspects

The chosen procedure was the adapted variant of eTEP, with minor deviations which included the camera port at the level of the umbilicus at the mid-clavicular line, a blunt videoscope retro-muscular dissection instead of balloon dissection and 2 trocars as working ports as opposed to 3 trocars. These changes allowed a more elaborate understanding by participants of the inguinal anatomy. Three surgeons took part in each procedure-a trainee as an operating surgeon, an assistant as a camera holder and a supervising mentor as an instructor. Participants' positions enabled the mentor to stand beside the trainee with 2 free hands and physically intervene if needed, depending on the trainees' level of autonomy. The time and the quality of the procedure were strictly controlled by the mentor which entailed close supervision and optimization of precise movements if needed. Each step was timed and assessed by the mentor by 3 degrees of autonomy: Dependent, partially dependent and independent, which were evaluated according to the need of physical intervention, vocal/command intervention or only observation, respectively. A short debriefing with comments for improvement followed completion of each procedure. The condition for successful completion of the course was a confident independent passage of all 5 steps in 2 consecutive eTEP procedures. Upon reaching the second level of autonomy at all 5 steps and in according to mentor's discretion regarding the trainees' display of proficiency, subsequent cases were performed by 2 surgeons with the trainee as operating surgeon and the mentor as camera holder.

Course program

The course consisted of two successive stages; each stage included theoretical and practical parts. The training process took place at a public hospital and a simulation center with trainees completing autodidactic assignments at their own pace.

The preparatory stage

Introductory lecture: The objective of the introductory lecture was to familiarize participants with the main concept and goals of the course while creating an atmosphere of dedication, confidence and motivation between mentors and participants.

Basic laparoscopy lectures: Consisted of two lectures regarding the physiology of laparoscopic surgery, basic principles of using laparoscopic equipment and safety requirements. These lectures also included descriptions of possible intra-operative complications, along with the principles of their prevention and treatment.

Laparoscopic instruments lectures: Consisted of five lectures dedicated to familiarizing participants with the basic laparoscopic equipment used in the operation-trocars, optics, graspers, energy sources, meshes and fixation devices.

Simulation: Preoperative simulation included five blocks of three hours each at the simulation lab and included both computerized/onscreen and manual models. Following traditional exercises of basic laparoscopic techniques, several elements of eTEP steps were simulated as well, such as the establishment of a straightened mesh in a confined space using laparoscopic instruments.

Assistance in laparoscopic procedures: Participants were required to manage the preparatory preoperative stage of different laparoscopic procedures, which included patient positioning, equipment setup and assisting as camera holders. Participants from group A assisted in over 2 dozen cases and participants from group C assisted in one case with the mentor prior to starting the course.

The principal stage

Hernia lectures: Consisted of three lectures that incorporated images and video clips from abdominal wall and groin surgery with an emphasis on anatomy of the abdominal wall and groin; pathophysiology, diagnosis and treatment of inguinal hernias; operative technique of TEP and eTEP.

Assistance in TEP and eTEP: Identification of anatomical structures of the abdominal wall and the groin in accordance with the "critical view of the myo-pectineal

orifice" as described by Felix and Daes was emphasized during assisting procedures. The mentor provided a detailed explanation of the technique for performing each step to the finest detail.

Out-patient abdominal wall clinic: Each resident was required to participate in the management of patients at the clinic and follow-up his own patients, which were followed up as per the usual recommendations of our institute: 1 month and 1 year post-operatively for assessment of recurrence, pain and disability. In case of clinical findings of any deviation from the regular post-operative course, patients were invited for further evaluation at 3 and 6 months post-op.

Performing surgery as an operating surgeon: Briefing and presentation of the case prior to each procedure by the trainee included clinical details, physical exam findings, review of imaging if present, detailed plan of the procedure and listing of all steps of the operation.

Post-operative autodidactic assignments: Video assessment and review by the trainees along with mentor assessment was obliged following each case and logged into the participants' logbooks *via* excel spreadsheets. The logbook included the timeframe, difficulties and mentors' autonomy assessment for each step. The records were subsequently used to assess the progress of the participants. Following self-review, an additional review of the video was made by all participants of the case along with mentors' comments and instructions of specific difficulties the trainee encountered in each step. All videos were deleted at 30 days following surgery as requested by the IRB.

Statistical analysis: Data analysis was performed using SPSS version 25 (Armonk, NY) software with two-sided significance level of α=0.05. Descriptive statistics are presented using prevalence and percentage values for categorical variables, while continuous variables are presented with means and standard deviation, skewed distributed variables are presented by median and range. Group comparisons were tested using Mann-Whitney U test for non-parametric comparisons. Categorical comparisons were tested using the χ^2 test or the Fisher's exact test, as appropriate.

During the study period, 44 procedures were performed, including overall 220 steps in the final analysis. Group A residents performed 10-12 cases, group B and C residents performed 4-6 cases each. Residents from group A achieved the 2nd and 3rd degrees of autonomy after 5-6 cases and full autonomy following 10 cases. The mean length of operation was 35.6 minutes (range 15-58 minutes). Overall, late procedures presented with a significant autonomy improvement in all degrees of autonomy (1st degree p=0.002, 2nd degree p=0.007 and 3rd degree p<0.0001) and in every step (step 1 p=0.015, step 2 p=0.006, step 3 p<0.0001, step 4 p<0.0001, step 5 p=0.002). There was no significant difference in surgery duration which did not exceed 60 minutes (p=0.32). When performing subgroup analysis, the same significant improvement was demonstrated for groups A and B regarding 1st and 3rd degree of autonomy, but for the 2nd degree of autonomy (vocal guidance) there was no significance improvement (p=0.12 for group A, p=0.6 for group B). Group C were touch independent from their first procedure hence could not improve in the 1st degree of autonomy. For comparison the sample was divided into two seniority-based groups, the junior residents (groups A and B) and the senior residents (group C). At early procedures junior residents needed significantly higher rates of physical intervention (1st degree) compared to the senior residents (p=0.004), in contrary, there was no significant difference in 2nd degree of autonomy (p=0.46), 3rd degree (p=0.06) and surgery duration (p=0.16). At later procedures, senior residents presented with significantly higher 3rd degree of autonomy (p=0.02) and 2nd degree of autonomy (p=0.025), on the other hand, the junior residents had similar 1st degree autonomy levels (p=0.13) compared with the senior residents, these might be due to the major improvement in the junior group. When assessing the last 3 procedures by all participants, there was no significant difference between the seniority groups in any degree of autonomy (1st degree p=0.1, 2nd degree p=0.18 and 3rd degree p=0.1).

At 1-month follow up all patients had an uneventful post-op course without documented recurrences, none of the patients were on opiate analgesics, and there were no re-admissions.

DISCUSSION

Despite the introduction of novel surgical methods, newly designed instruments and innovative assessment methods, the teaching of such capabilities to a level of adequate competency is a challenge for many residency programs. Due to a heavy work load, long residents working hours and a mentor-apprentice scholarly relationship that hasn't changed in over a century, there is a constant discordance between the technical complexity of performing modern surgery and the level of training provided during surgical residency. Furthermore, residents are not obliged to show technical competence in performing any type of procedure in order to graduate, which may contribute to the low level of self-confidence graduating surgeons proclaim.

A prominent example of a common complex procedure required to master by graduating surgeons is the laparoscopic repair of inguinal hernias. While this approach is becoming the "gold-standard" of inguinal hernia repairs, many centers lack the ability to adequately perform it laparoscopically, nonetheless teach it to residents.

Guiding residents and young surgeons how to operate poses many challenges for both trainees and mentors, and thus several methods have been proposed with the objective of instilling surgical abilities of complex procedures for surgeons in training. The "Zwisch model" published in 2013 by Debra, et al. [1] is a prominent example of a training assessment model that monitors a residents' gradual stepwise progression through complex surgery, with specific cues that indicate readiness of advancement

to subsequent stages. The steps of the "Zwish" model assess how prepared the resident is, in regards to the type of help he or she requires to complete a specific task during surgery. The gradual achievement of autonomy helps relieve tensions between mentors and trainees, which directs the focus of the operation towards a common goal of skill and knowledge transference. Deliberate Practice (DP), as described by Eriksson, et al., is an education process which aims to maximize one's abilities to reach superior performance and exceptional achievements by understanding underlying methods and mechanisms of a certain skill. The key elements of DP include motivation, predefined goals for tasks, measurability, focused repetition and feedback. DP has been described in multiple disciplines of arts and sports with medical education also gaining popularity in recent years. Several methods of teaching laparoscopic inguinal hernia repair have also been described with favorable outcomes. A mono-blinded randomized control trial by Zendejas, et al. examined residents' proficiency in performing TEP with or without a mastery level course, showed decreased operative times, improved trainee performance and decreased post-operative complications in residents who underwent a dedicated course in laparoscopic TEP repairs. In a systematic review by Kockerling F. which investigated the influence of well-structured simulation-based training courses, the author concluded this learning approach shortens the learning curve and improves surgical skills of trainees, while reducing the post-operative complication rate [2].

These educational examples have provided the foundations of our proposed model, in which we attempted to overcome the shortcomings of previous models, by directing the method of training towards a laparoscopic orientation and to have the ability to quantify the progression of trainees. Our results support similar attributes of previous studies in surgical training, with both junior and senior residents showing improvement in all steps in late *vs.* early procedures. The significant differences seen between junior and senior residents regarding progression in 1st degree of autonomy may be explained by the fact that seniors had initial lower physical dependency, which was maintained throughout their progression. Nevertheless, this progression in autonomy of junior residents to match the proficiency of seniors may hint of an effective way to shorten the learning curve of eTEP and overcome the seniority-gap between groups. The autonomy gained by junior residents allowed equivalent interventions by the mentor as with senior residents, which further strengthens our aim. Conversely, junior residents did not improve their 2nd degree of autonomy (vocal/command assistance) as well as the senior residents did, which shows a baseline lower confidence level of juniors *vs.* seniors. Although an inherent observational bias, the finding of senior residents reaching full autonomy faster than the juniors proves that prior surgical experience plays a role in both the proficiency of residents and in the confidence of the attending in charge. The complete autonomy observed by all participants on the last 3 cases of late procedures without difference in seniority (1st degree p=0.1, 2nd degree p=0.18 and 3rd degree p=0.1) further endorses our assumption that a dedicated multimodal curriculum may resolve the gap difference in experience between junior and senior residents. Our proposed model differs from conventional surgical education methods by allowing the mentor to have complete control of the procedure and intervene with 2-hand manipulation as needed. Autodidactic review of the recorded videos allowed the trainees a visual self-evaluation of each step separately, followed by a comprehensive assessment by the mentor which we believe had a positive impact on residents reaching autonomy quicker.

Residency programs worldwide aim to train graduating surgeons as experts in their field. In order to achieve this goal, programs have a pre-determined amount of cases which residents have to participate in order to graduate, which are typically set by national organizations or government standards. Nevertheless, the amount of procedures performed in order to achieve an expert level of proficiency, differs between residents and the obligation of reaching the set quota for each procedure, is not dependent on demonstrating competence. Mentoring junior residents in complex cases requires experience, patience and trust. Participation of an experienced mentor in the operation allows a mentor-apprentice skill transference which reduces the amount of repetitions required to achieve a safe level of autonomy while performing the eTEP procedure. Our findings echo the findings of a systemic review by Kockerling [2], which stated the crucial role of the mentor in the residents' ability to overcome the learning curve and that in order to maintain patient safety, an experienced mentor supervision is essential. As our results show, senior residents had initial less physical interventions and needed less vocal assistance compared to junior residents, which advocates their previous surgical experience had a positive effect on their speed of acquiring autonomy in performing unfamiliar laparoscopic procedures. However, it is also clear that additional training elements can bridge the experience gap in trainees with limited laparoscopic exposure. These elements can be seen in several steps during our course. First, participation as an assistant in procedures performed by other course participants, allowed observing common difficulties and errors shared by trainees. Second, self-review of video materials from previous procedures, along with the corresponding mentor comments of each step. Third, recording the gradual progression in a surgical logbook dedicated to eTEP by the resident in a spreadsheet. Besides the contribution to resident progression assessment by the mentor, record logs of the multiple attempts of the same procedure have allowed the trainees to witness their own progression and gain confidence with each subsequent attempt. Proficiency assessment according to 3 degrees of autonomy with a clear and understandable distinction between degrees has allowed participants to understand their strengths and weaknesses, a feature we believe contributed to the rapid progression in competency and confidence. The use of this autonomy scale proved to be a valuable tool of resident assessment by the mentor

regarding their overall laparoscopic abilities and a nominal method for statistical analysis.

Surgery is constantly advancing. The innovation and technological advancements seen in the last 3 decades are a giant leap compared to the surgical abilities of the preceding century and one can only imagine how the future of surgery will unfold. Nevertheless, surgical education is progressing at a much slower pace to meet our demands of resident training that will raise expert surgeons with confidence and proficiency that are up to date with novel surgical techniques. While some residents require few repetitions until reaching adequate proficiency, other residents require a substantial amount of repetitions to master it. If we are to raise the next generation of surgeons to be able to adapt to new technology, a proper education system is needed, one that will shorten learning curves and allow young trainees to master common procedures rapidly, regardless of complexity. Limitations of the study include it's obvious observation bias due to un-blinding of the mentor.

There was also a time-gap between operations due to resident availability, thus, participants often had long interruptions between course sessions and surgery. Unfortunately, the schedule of our surgical service could not support a clustered course during regular working hours. Furthermore, the course requires a highly experienced tutor to manage the teaching of participants, recognize pitfalls and take responsibility on patient safety. Participants of group B were not able to take part in all activities of the preparatory and the main stage, and were limited in the number of operations as an assistant to two operations.

CONCLUSION

Despite these limitations, our results show an unconditional effectiveness of our proposed course. To our knowledge, there are no other publications in the literature regarding a faster achievement of independence in performing laparoscopic inguinal hernia repairs by residents at an early stage of residencyA multimodal curriculum in a designated and methodological course is effective in achieving competence, autonomy and confidence in performing eTEP in a short period of time and reduces the long learning curve of laparoscopic inguinal hernia repair.

REFERENCES

1. **DaRosa DA, Zwischenberger JB, Meyerson SL, et al.** A theory-based model for teaching and assessing residents in the operating room. *J Surg Educ*. 2013;70: 24-30.
2. **Köckerling F.** What is the influence of simulation-based training courses, the learning curve, supervision, and surgeon volume on the outcome in hernia repair?-a systematic review. *Front Surg*. 2018;5: 57.
3. **Antoniou SA, Antoniou GA, Antoniou AI, et al.** Past, present, and future of minimally invasive abdominal surgery. *JSLS: J Soc Laparoend Surg*. 2015;19.
4. **Lane T**. A short history of robotic surgery. *Annals R Coll Surg Engl*. 2018;100: 5-7.
5. **Bell RH**. Why Johnny cannot operate. *Surg*. 2009;146: 533-42.
6. **Fonseca AL, Reddy V, Longo WE, et al**. Operative confidence of graduating surgery residents: A training challenge in a changing environment. *Am J Surg*. 2014;207: 797-805.
7. **Mattar SG, Alseidi AA, Jones DB, et al**. General surgery residency inadequately prepares trainees for fellowship: Results of a survey of fellowship program directors. *Ann Surg*. 2013;258: 440-9.
8. **McKenna DT, Mattar SG**. What is wrong with the training of general surgery? *Adv Surgery*. 2014;48:201-210.
9. **Thinggaard E, Konge L, Bjerrum F, et al**. Take-home training in a simulation-based laparoscopy course. *Surgl Endosc*. 2017;31: 1738-45.
10. **Nilsson C, Sorensen JL, Konge L, et al**. Simulation-based camera navigation training in laparoscopy-a randomized trial. *Surg Endosc*. 2017;31: 2131-9.
11. **Moglia A, Sinceri S, Ferrari V, et al**. Proficiency-based training of medical students using virtual simulators for laparoscopy and robot-assisted surgery: Results of a pilot study. *Updates Surgs*. 2018;70: 401-5.
12. **Suguita FY, Essu FF, Oliveira LT, et al**. Learning curve takes 65 repetitions of totally extraperitoneal laparoscopy on inguinal hernias for reduction of operating time and complications. *Surgl Endos*. 2017;31: 3939-45.
13. **Schouten N, Simmermacher RK, van Dalen T, et al**. Is there an end of the "learning curve" of endoscopic Totally Extraperitoneal (TEP) hernia repair? *Surg Endoscop*. 2013;27: 789-94.
14. **van Veenendaal N, Simons MP, Bonjer HJ**. Summary for patients: international guidelines for groin hernia management. *Hernia*. 2018;22: 167-8.
15. **Miserez M, Arregui M, Bisgaard T, et al**. A standardized resident training program in endoscopic surgery in general and in laparoscopic Totally Extraperitoneal (TEP) inguinal hernia repair in particular. *Surgl Laparosc Endosc Percutaneous Techn*. 2009;19: 125-9.