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Effectiveness of telesimulation for pediatric minimally invasive surgery essential skills training

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ABSTRACT

Background: In the context of the COVID-19 pandemic and social distancing rules, access to in-person training activities had temporarily been interrupted, speeding up the implementation of telesimulation for minimally invasive surgery (MIS) essential skills training (T-ESTM, Telesimulation - Essential Skills Training Module) in our center. The aim of this study was to explore the effectiveness of T-ESTM.

Methods: T-ESTM was scheduled into 2 sessions of 3 h through the Zoom® virtual meeting platform. The academic lectures, the tutorials for box-trainer set-up and 7 performance tasks were accessed through an online campus previous to the remote encounter for personalized guidance and debriefing.

Initial (pre-telementoring) and final (post 6-hour telementoring) assessment scoring as well as timing for Task 2 (circle-cutting pattern), 3 (extracorporeal Roeder knot) and 5 (intracorporeal Square knot) were registered.

Results: 61 participants were recruited. The mean age was 31±5 years. 65% were surgical residents. 48% performed low complexity procedures. 52% had previous experience with simulation training.

In Task 2, there was a 21% improvement in the final score obtained, as well as a significant decrease in time of 33%; in Task 3, there was an increase of 39% in the scoring and a decrease of 49% in the timing; and in Task 5, participants improved their technique a 30% and decreased the performance time a 47%. All the differences were statistically significant.

Discussion: Our data support T-ESTM as a reproducible and effective educational tool for remote MIS essential skills hands-on training.

Level of Evidence: II

1. Introduction

Contrasted to open surgical techniques, minimally invasive surgery (MIS) procedures require apprehension of additional psychomotor skills related to ergonomics, ambidexterity, haptic competencies, and coping with the fulcrum effect; the entire performance has to be done through indirect, two-dimensional vision [1,2]. Studies have demonstrated that the learning process of these non-procedure-specific essential skills should start in a simulated, safe and stressless environment [3–5]. Thus, it can be tainted or ineffective without the proper compliance of the three interdependent conditions involved in all learning processes: equipment, training program and educator [6].

In search of more accessible and feasible training for the essential skills, our Surgical Simulation Department developed a fellowship with projects centered in designing and validating inanimate, low-cost MIS training models and modules. Some of the training models were adapted from other validated programs like MISTELS (McGill Inanimate System for Training and Evaluation of Laparoscopic Skills) [7] and FLS (Fundamentals of Laparoscopic Skills) [8]. This enabled our surgical trainees to acquire the MIS technical skills in a supervised, safe, standardized environment at the same time of the gestation of educators and instructors by developing and validating inanimate skill-training modules (https://www.youtube.com/channel/UC_VaZq22_cD2kvpO3×9XQtQ).

Since 2012, our surgical simulation team has been committed to encourage MIS training through low-cost hands-on courses for

Abbreviations: MIS, minimally invasive surgery; FLS, Fundamentals of Laparoscopic Skills; MISTELS, McGill Inanimate System for Training and Evaluation of Laparoscopic Skills; ESTM, Essentials Skills Training Module; cm, centimeter; ml, milliliter; mm, millimeter; GOALS, Global Operative Assessment of Laparoscopic Skills; SD, standard deviation.

Previous communication: preliminar data was presented at Virtual International Pediatric Endosurgery Group 2021 Annual Meeting and was recognized with an International Award.

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surgical practitioners and integrated them into the surgical residency curriculum of our institution. Most of the simulation models have been designed and handmade within our teamwork, while developing cognitive-comprehensive surgical modules in 3 stages of complexity. The initial approach was focused on essential psychomotor skills acquisition while the subsequent stages looked for more advanced and low frequency procedure-linked and specialty-linked abilities. [9–12].

In 2018, the 12-h Hands-On Essential Module was adapted into a 4-h pre-congress course (International Pediatric Endoscopic Group 2019 Annual Meeting), and the Essentials Skills Training Module (ESTM) was launched. The optimization of the time had been achieved by fully personalized guidance of a maximum of 2 trainees interacting with one faculty, and the assessment showed positive impact in the skill acquisition.

Telesimulation was defined by McCoy et al. [13] as a distance learning method in which telecommunication and simulation resources are utilized together to build knowledge and provide skills training. It had been requested in several circumstances and appeared as a feasible training tool to save trainees' time, distances and cost [14,15]. Its feasibility for surgical education programs such as FLS has been reported [16–18].

In the context of the COVID-19 pandemic and social distancing rules, access to in-person training activities had temporarily been interrupted, speeding up the implementation of telesimulation in our center. With previous experience in MIS-telesimulation and telementoring [19], we decided to adopt the ESTM for the implementation of a tele-assisted training module (T-ESTM).

The aim of this study is to explore evidence of effectiveness of T-ESTM, a 6-h telementored training module for laparoscopic essential skills.

2. Methods

This research was applied for evaluation by the institutional ethics committee, who determined that no approval was needed.

2.1. Essential skills training module (ESTM)

2.1.1. The training box

We propose a panel with a 6 × 4 cm (cm) window and a support to fit any tab or pad type smart device as a functional camera and screen, adopted and modified from the iPhone trainer described by Perez Escamirosa et al. [20]. The recommendation is that the 2 port-placement holes should be between 12 and 18 cm to help the ergonomics of the instruments' angulation and plane for the proposed tasks. As we work in the pediatric environment, the dimensions for training are at least a third smaller than most of the box-trainers used in general surgery, defining a working area between 1300 and 1800 mL (ml). Each center reproduced its training box with 3D printing or low-cost materials, according to these recommendations (Fig. 1a, b, c)

2.1.2. The set of inanimate surgical models

We use 3 multi-functional 13 × 13 cm square plates to fit properly the 9 surgical-task models proposed. The wooden square-plates are 5 mm (mm) height and are covered by a soft neoprene surface. They are durable, easily cleaned and disinfected, and they can be independently fit inside of other training boxes (Fig. 2).

Square-plate 1: contains a fixed cord, 5 beads of one color, and 5 of another color.

Square-plate 2: contains a 3 cm bulldog clip at the top edge and 2 alligator clips, one at each side of the bottom edge of the plate.

Square-plate 3: contains 2 opposing clothespins.

Fig. 1. Training Box Assembly (A) 3D-printing adapted training box with smart device as a functional camera and screen. (B) Low cost endotrainer with smart device as a functional camera and screen. (C) Other option of 3D-printing endotrainer. (D) Workstation Assembly. A second device is used as an external camera for assessing ergonomics.

2.1.3. The tasks

The selected tasks for this module embraces appropriate ergonomics, handling of laparoscopic instruments, coping with the fulcrum effect, and the essential skills for hand-eye coordination, bimanual dexterity, economy of movement, safe knot-tying and suturing.

Task 1 Bead-into-string transfer for hand-eye coordination (Fig. 2a).

Equipment: 2 Maryland-type dissectors and *Square-plate 1*. Time limit: 1200 s.

Training goals: Grab the string at the side of the non-dominant hand, grasp the bead with the dominant hand and transfer it into the string until completing 8 beads rosary of alternated color.

Task 2 Circle-pattern cutting for precision (Fig. 2b).

Equipment: 1 pair of endoscopic scissors, 1 Maryland-type dissector, the *Square-plate 2* that is grabbing a 5 cm non-woven fabric pad with a pre-printed 3 cm circle. Time limit: 1200 s to cut two circles.

Training goals: cut the circle with the dominant hand delimiting outside the mark, we recommend to go from 5 to 11 clockwise and then 5 to 12 counter-clockwise; consider the optimal orientation of the scissors and instruments should not be hand-switched; the non-dominant hand (dissector) should escort by providing the adequate traction. The task ends when the circle is completely cut off. The first performance of this task is specifically assessed and registered by the instructor as initial scoring.

Task 3 Roeder-type extracorporeal knot for loop ligation and stereotaxic skills (Fig. 2c).

Equipment: 2 Maryland-type dissectors, 1 pair of endoscopic scissors and the *Square-plate 2* that is grabbing a 3-appendage pattern eva rubber, at least three 90 cm threads . Time limit: 1200 s.

Training goals: pre-tie (according to Roeder-knot technique) at least 3 ligating loops; use dominant hand (dissector) to place the ligating loop on the base of the appendage, the long tail of the loop must be left outside the entrance to the trainer/trocar; if necessary, the non-dominant hand (dissector) can assist by going into the loop to grasp one appendage and the dominant-hand skid the loop to the appedange base. Once the loop is in the correct position, the non-dominant hand should drop the instrument

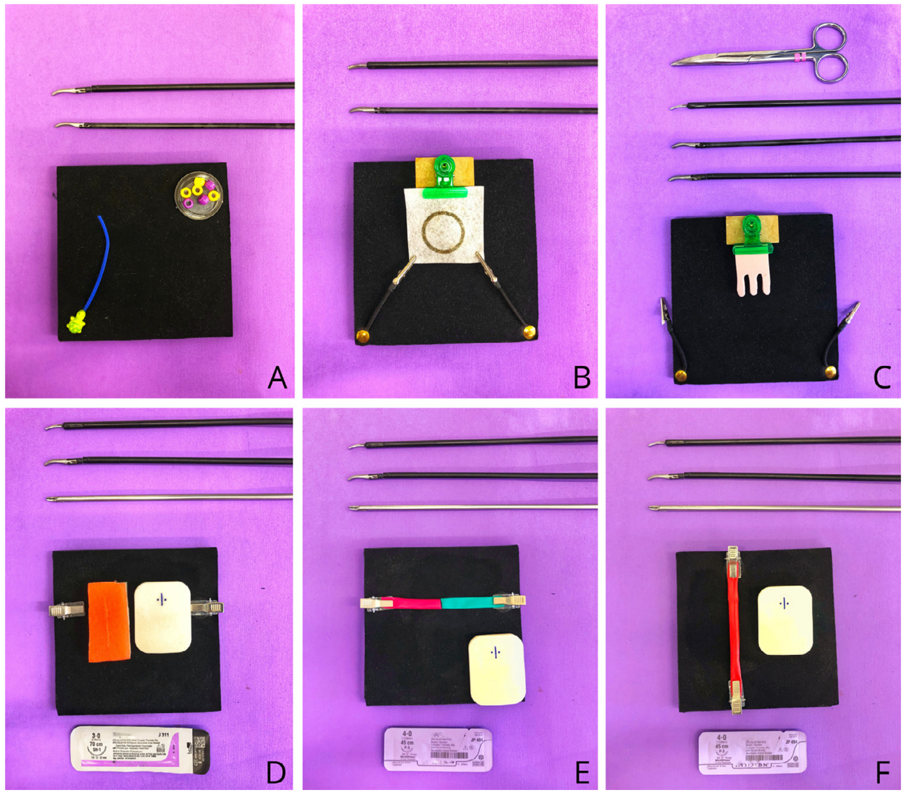

Fig 2. T-ESTM inanimate surgical models (A) Bead-into-string transfer for hand-eye coordination (Task 1) (B) Circle-pattern cutting for precision (Task 2) (C) Roeder-type extracorporeal knot for loop ligation and stereotaxic skills (Task 3) (D) Needle grabbing for haptics (Task 4) and Intracorporeal square knot for ambidexterity (Task 5) (E) Tubular Suturing for essential skill integration and strategy (Task 6) (F) Continuous Suturing for economy of movements (Task 7).

to directly pull the long thread of the loop to ligate, while the dominant hand escorts the knot towards the appendage base until it is tight and secured. Finally, secure and lock the knot by pulling the short end of the loop in the opposite direction of the long tail. The task ends when the long tail is cut off. The first performance of this task is specifically assessed and registered by the instructor as initial scoring.

Task 4 Needle grabbing for haptics (Fig. 2d).

Equipment: 1 needle holder, 1 Maryland-type dissector, 1 pair of endoscopic scissors, one 3–0 suture of 25 cm length and the *Square-plate 3* with a 3 × 4 cm makeup sponge (reversibly fixed to the center of the plate with Scotch or Velcro). Time limit: 1200 s.

Training goals: introduce the suture into the trainer by grasping from the thread 2 to 3 cm from the swedge of the needle. Correctly place the needle in a “smiley” or upright position by grabbing it on its posterior half, ideally two-third away from the needle-tip, and perpendicularly with the tip of the needle-holder jaw. To lock the needle-driver with the needle correctly loaded, make sure to click only on the first ratchet, this simple care can extend the useful life of the tool. 3 methods for manipulating the needle are rehearsed: first, drop and set the needle at least 5 times with one hand manipulation, the “press-down and roll-up” technique; then, drop and set the needle at least 5 times with two hand manipulation technique, positioning the needle in the right angle with dragging motion or pulling from the suture to the zenith approximately at the point of 2 cm from the swedge of the needle; and last, drop and set the needle at least 5 times with two hand manipulation technique, positioning the needle in the right angle by using rotation of the assistant hand to slightly change the orientation of the needle.

Task 5 Intracorporeal square knot for ambidexterity (Fig. 2d).

Equipment: 1 needle grabber, 1 Maryland-type dissectors, 1 pair of endoscopic scissors, one 3–0 suture of 25 cm length, the *Square-plate 3* with a 3 × 5 cm sponge with a 4 cm cut in the middle, and a makeup sponge to aid needle setting (both reversibly fixed to the plate with Scotch or Velcro). Time limit: 2400 s.

Training goals: introduce the suture into the trainer by grasping from the thread 2 to 3 cm from the swedge of the needle. Set the needle in the correct position. Pass the needle perpendicularly through one or both cut edges of the sponge (as for tissue re-approximation), it is of good practice that the assistant hand grab near the passing point of the needle to provide adequate traction and precision. Once the needle tip is out of the second edge, it is pulled out with rotation movement, then use the pulley maneuver to pull from the thread until a 2.5 cm tail is left at the entrance edge. Proceed with intracorporeal knot-tying by pursuing the square-knot technique (first double-throw followed by two single and opposite throws; note that throwing hands should be changed in each step to train the ambidexterity). Make at least 4 stitches with the same technique with the same suture. To save suture, time and movements; avoid long tails. Security of the knots are specifically assessed and revised after the task. The first performance of this task is specifically assessed and registered by the instructor as initial scoring.

Task 6 Tubular Suturing for essential skill integration and strategy (Fig. 2e).

Equipment: 1 needle grabber, 1 Maryland-type dissectors, 1 pair of endoscopic scissors, one 3–0 suture of 25 cm length, the *Square-plate 3* grabbing with the clothespins 2 lined latex tubes with a 5 mm space between them, and a makeup sponge to aid needle setting. Time limit: 2400 s.

Training goals: introduce the suture into the trainer by grasping from the thread 2 to 3 cm from the swedge of the needle. Set the needle in the correct position. Make an end-to-end anastomosis of the 2 tubular structures by placing four cardinal stitches with the square-knot technique with the same suture. The first stitch must be laid on the posterior side of the tubes, to be continued with the lateral sides (superior / inferior), and on the anterior plane is the last knot to place. The security of the knots, the adequate alignment of the anastomosis and patency are carefully assessed.

Task 7 Continuous Running Suture for economy of movements (Fig. 2f)

Equipment: 1 needle grabber, 1 Maryland-type dissectors, 1 pair of endoscopic scissors, one 3–0 suture of 25 cm length, the *Square-plate 3* grabbing with the clothespins 1 latex tube with a 8 cm longitudinal cut in the middle and a makeup sponge to aid needle setting. Time limit: 2400 s.

Training goals: introduce the suture into the trainer by grasping from the thread 2 to 3 cm from the swedge of the needle. Set the needle in the correct position. Approximate the superior angle of the longitudinal cut by anchoring a square knot, continue caudally with a running suture passing the needle with 1 cm distance. Set the needle on the driver near the exit of the latex tissue and pull the suture through with the pulley technique. Lock the running suture with the aid of the assistant hand by adequately pulling the suture near the exit edge and cross it backwards every 3 passages of the needle to re-approximate the tissue. Close the running suture with a square-knot at the inferior angle of the middle cut.

Task 8 Final assessment and scoring of Tasks 2, 3 and 5. Time limit: 1800 s.

2.2. Participants

Participants with different levels of training and experience in MIS and simulation training including residents, fellows, and staff from different institutions from Argentina, Brazil, Costa Rica, Guatemala and Peru were invited to participate, after agreements between the heads of Surgery Department. All participants provided written consent.

2.3. The T-ESTM - Telesimulation Sessions

Prior to the remote encounter, the academic lectures, Hands-On tutorials for the training- model assembly, ergonomics and required performance tasks were accessed through the online campus.

The whole telementored module was set up in 2 sessions of 3 h through the Zoom® virtual meeting platform. It consisted of: discussion of the virtual campus content followed by practice of tasks with summative feedback, assessing hands-on performance, followed by debriefing.

We used assigned *break-out rooms* provided by the virtual platform during hands-on practice so that each trained instructor worked only with one or two trainees and avoided overlapping voices. Previous to the encounter, the trainees had prepared the workstation according to the tutorials. The set-up was then tested under tutor-guidance. The instructor followed the images from both the device used in the endotrainer and a second one (mobile phone, webcam) used as an external camera for assessing ergonomics (Fig. 1d). In each room, only one device could have the microphone on, the rest of the connected devices had to be muted to prevent echoes or interferences.

Multiple-choice exam should be completed within 24 h of the last session.

Each participant completed a satisfaction survey where experience in each component of the T-ESTM program was evaluated.

2.4. Data collection

Participants completed a pre-module survey to determine demographics, as well as prior experience in MIS and simulation training.

During de Hands-On practice, initial (pre-telementoring) and final (post-telementoring) assessment scoring for Task 2, 3 and 5 (adapted and validated for remote evaluation from Global Operative Assessment of Laparoscopic Skills (GOALS) [21]) as well as timing were registered by the same instructor using an online Google-form®.

2.5. Statistical analysis

For continuous data, mean and standard deviation (SD) were calculated and paired *t*-test used for comparison pre (initial) and post (final) training.

A *p*-value <0.05 was considered statistically significant.

Data was analyzed with STATA 12.0 software program.

3. Results

3.1. Demographics

All participants completed the pre-module survey and accessed through online campus the academic lectures and Hands-On tutorials previous to the remote session.

61 participants from different institutions from five latam-countries were included. The mean age was 31±5 years.

65% were surgeons in training, 23% were pediatric surgeons and 12% were general surgeons.

Only two were left-handed, that trained ambidextrously complying with the adequate ergonomics and comfort [22].

In relation to the prior experience in MIS: 19% lacked of experience or had only played an assistant role; 48% had done low complexity (suture-skill not demanded) procedures; 19% had performed procedures that required extracorporeal suturing skills; 9.6% had reported intracorporeal suturing skills; and only 4% performed high complexity procedures.

In contrast to the frequency of surgical activity: 8% did not operate minimally invasive procedures; 51% performed 1 or less MIS weekly; 31% between 1 and 3; and 10%, more than 3 MIS procedures weekly.

In reference to simulation training experience: 31% had never accessed a simulation-based training course; 17% only once; 39% had previous experience with simulators sporadically; and 13% frequently.

All participants completed 6 h of telesimulation training module for development of MIS essential skills and the multiple-choice exam.

The results of the initial and final task-specific assessments with the GOALS-form scoring and the timing are shown in Tables 1 and 2.

In Task 2 - Circle-pattern cutting for precision, there was a 21% improvement in the final score obtained, as well as a significant decrease in time of 33%.

In Task 3 - Roeder-type extracorporeal knot for loop ligation and stereotaxic skills, there was an increase of 39% in the scoring and a decrease of 49% in the timing.

In Task 5 - Intracorporeal square knot for ambidexterity, participants improved their technique a 30% and decreased the performance time a 47%.

Statistically significant differences in the scoring and timing were observed for all the assessed tasks.

Fig. 3 exhibits the variations in the initial results obtained in the score with those obtained at the end of the practice for the 3 assessed tasks. The results indicated significant improvements with a more symmetric distribution after training.

Fig. 4 illustrates the comparison between the initial time versus final time for the 3 tasks. It also exposes that participants as a group achieved a more symmetric distribution after training.

Table 1
Comparison in mean scores assessment registration.

SCORE	Initial assessmentMean ± SD	Final assessmentMean ± SD	ImprovementMean Difference (95%CI)	P-value
Task 2	14±3	17±2	2.9 (3.4- 2.3)	$p<0.001^*$
Task 3	14±4	19±4	5.4 (6.3–4.4)	$p<0.001^*$
Task 5	20±4	26±3	6 (7–4.7)	$p<0.001^*$

Initial and final score assessment were presented as mean with standard deviation (SD).
Improvement was presented as mean difference and 95% confidence interval (95%CI).
Significant differences between initial and final score assessment ($p<0.05$) were calculated with paired *t*-test.

Table 2
Comparison in mean time assessment registration.

TIME	Initial assessmentMean ± SD	Final assessmentMean ± SD	ReductionDifference mean (95%CI)	P-value
Task 2	361±145	242±93	−118.9 (87.6- 150.2)	$p<0.001^*$
Task 3	331±257	169±105	−161.6 (106.8–216.5)	$p<0.001^*$
Task 5	438±348	233±119	−205.5 (129.7–281.2)	$p<0.001^*$

Initial and final time assessment were presented as mean with standard deviation (SD).
Reduction time was presented as mean difference and 95% confidence interval (95%CI).
Significant differences between initial and final time assessment ($p<0.05$) were calculated with paired *t*-test.

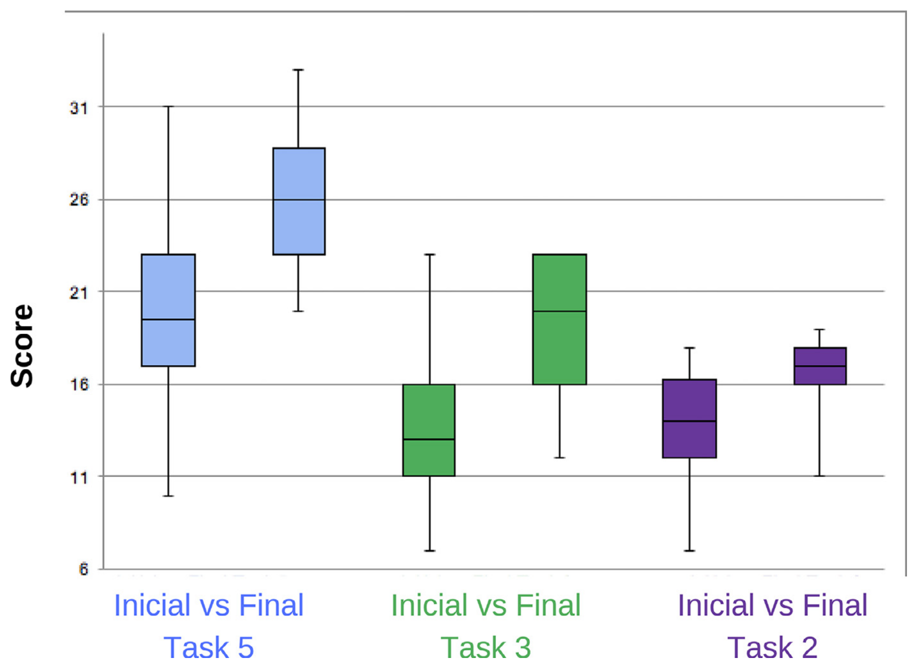

Fig. 3. Comparison between initial versus final score in task 2, 3 and 5. Comparison between initial and final score in intracorporeal square knot assessment (blue), extracorporeal knot assessment (green) and circle pattern cutting (purple). All the differences are statistically significant and all the groups had a more symmetric distribution after training.

In the post-module satisfaction survey, 87% qualified the workstation as simple and easy to assemble, 73% believed that they would always practice laparoscopic skills in their own simulator in the future, and 27% alleged that they would do it frequently.

68% rated the virtual campus experience as excellent, and 32% as very good. 57% rated the quality of electronic devices, video and connection as excellent, 33% as very good and 10% as good. 98% believed that no time was wasted. 74% rated the remote instructor training experience as excellent and 26% as very good.

Finally, 98% believed that telesimulation can achieve the same objectives as in the traditional direct system for hands-on training and a 100% would recommend the telesimulation module and would take another course with this modality.

4. Discussion

The COVID-19 pandemic and social distancing rules imposed the restriction of in-person activities. Consequently, distance training became a priority to continue with simulation-based surgical education. Many studies demonstrated the benefits of telesimulation allowing access to educational content from remote locations and promoting multicenter activities, reducing travel time and costs [14–17]. In this context, many educational centers adapted their programs to this modality [23,24].

Our experience in MIS education has been previously reported [9-13,25-27]. The challenge this time was to reproduce the ESTM through telesimulation modality, T-ESTM. From the results, we have observed statistically significant improvements in the scoring and reduction in time for all the assessed tasks. In addition, at the end of the training module, the group of trainees acquired a more symmetric distribution of the scoring and timing, which we interpret as a more homogeneous performance and as reduced variability between participants at the end of the training module. The beneficial results were noticed in all participants, even in the more experienced trainees; as well as in the Task 5 for intracorporeal suturing, it marked the most important differences between

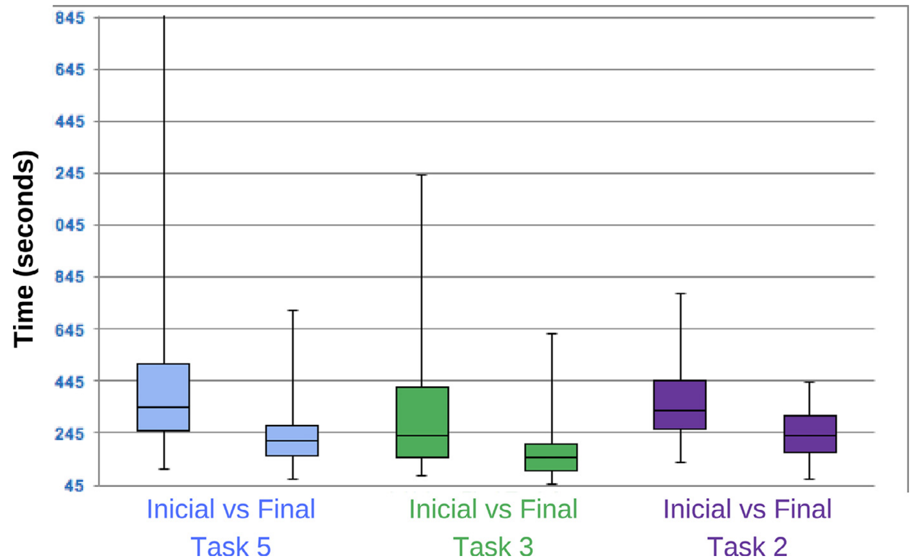

Fig. 4. Comparison between initial versus final time in task 2, 3 and 5. Comparison between initial and final time in intracorporeal square knot assessment (blue), extracorporeal knot assessment (green) and circle pattern cutting (purple).
All the differences are statistically significant and all the groups had a more symmetric distribution after training.

the initial and final results, that could be explained by its particular complexity.

Current advances in communication and information technologies should be turned into useful tools to facilitate access to surgical education. The required equipment and materials used at T-ESTM were low-cost and easily accessed providing adequate communication, visual definition and little latency. The differential advantage is that trainees at off-site locations can access the same on-site hands-on training module with live and immediate feedback, reducing travel costs. Thus, we must refer to the presence of the instructors giving immediate feedback during the training sessions to optimize time and effectiveness of the module regarding the psychomotor skills apprehension.

Participants were satisfied and appreciative of the remote experience by not delaying their training curriculum, suggesting that this education strategy could be useful in reducing the distances and gaps in pediatric surgical education with the collaboration among different centers or institutions.

We identified some unavoidable bias throughout the study that included mainly the different environments regarding training-box sizes and instruments used during the sessions as participants were from different institutions and countries; another inevitable limitation concerned the internet connection disruption or delays that could time-lag temporarily the live guidance.

Our data encourages us to continue to support MIS telesimulation as a reproducible and effective educational tool for remote hands-on performance training, as well as the replicability of our experience in didactics and pedagogical approach.

It is a future aim to extend the validation by comparing the effectiveness of T-ESTM versus the standard on-site ESTM and continue the development of other skills training programs that could be feasible in both modalities.

Declaration of Competing Interest

None.

References

[1] Matern U. Ergonomic deficiencies in the operating room: examples from minimally invasive surgery. Work 2009;33(2):165–8. doi:10.3233/WOR-2009-0862.

[2] Berguer R, Smith W, Chung Y. Performing laparoscopic surgery is significantly more stressful for the surgeon than open surgery. Surg Endosc 2001;15:1204–7. doi:10.1007/s004640080030.

[3] Louridas M, Bonrath EM, Sinclair, et al. Randomized clinical trial to evaluate mental practice in enhancing advanced laparoscopic surgical performance. Br J Surg 2015;102(1):37–44. doi:10.1002/bjs.9657.

[4] Dehabadi M, Fernando B, Berlingieri P. The use of simulation in the acquisition of laparoscopic suturing skills. Int J Surg 2014;12(4):258–68. doi:10.1016/j.ijsu.2014.01.022.

[5] Vassiliou MC, Dunkin BJ, Marks JM, et al. FLS and FES: comprehensive models of training and assessment. Surg Clin North Am 2010;90(3):535–58. doi:10.1016/j.suc.2010.02.012.

[6] Sullivan ME. Applying the science of learning to the teaching and learning of surgical skills: the basics of surgical education. J Surg Oncol 2020;122(1):5–10. doi:10.1002/jso.25922.

[7] Vassiliou MC, Ghitulescu GA, Feldman LS, et al. The MISTELS program to measure technical skill in laparoscopic surgery: evidence for reliability. Surg Endosc 2006;20:744–7. doi:10.1007/s00464-005-3008-y.

[8] Fried GM. FLS assessment of competency using simulated laparoscopic tasks. J Gastrointest Surg 2008;12:210–12. doi:10.1007/s11605-007-0355-0.

[9] Maricic MA, Bailez MM. Neonatal surgical education in minimally invasive surgery based on simulation. In: Lima M, Reinberg O, editors. Neonatal surgery. Cham: Springer; 2019. p. 51–63. doi:10.1007/978-3-31993534-8_4.

[10] Chichizola JI, Bailez MM, Yang HC, et al. Education on endosurgery through simulation. experience at a training centre at a pediatric hospital IPEG's 27th annual congress for endosurgery in children, USA: Seattle; 2018. https://www.ipeg.org/wpcontent/uploads/2018/04/IPEG2018_FinalProgram_FINAL.pdf.

[11] Yang HC, Falcioni AG, Chichizola JI, et al. Baseline assessment metrics (Bam) of intracorporeal suturing and laparoscopic vessel sealing in pediatric MIS Experience in one Center; 2018. Seattle, USA https://www.ipeg.org/wp-content/uploads/2018/04/IPEG2018_FinalProgram_FINAL.pdf .

[12] Maricic MA, Bailez MM, Rodriguez SP. Validation of an inanimate low cost model for training minimal invasive surgery (MIS) of esophageal atresia with tracheoesophageal fistula (AE/TEF) repair. J Pediatr Surg Sep 2016;51(9):1429–35. doi:10.1016/j.jpedsurg.2016.04.018.

[13] McCoy CE, Sayegh J, Alrabah R, et al. Telesimulation: an innovative tool for health professions education. AEM Educ Train 2017;1(2):132–6. doi:10.1002/aet2.10015.

[14] Papagnou D. Telesimulation: a paradigm shift for simulation education. Acad Emerg Med 2017;1 Num2. doi:10.1002/aet2.10032.

[15] Augestad, et al. Educational implication for surgical telementoring: a current review with recommendations for future practice, policy and research. Surg Endosc 2017;31:3836–46. doi:10.1007/s00464-017-5690-y.

[16] Okrainec A, Vassiliou M, Kapoor A, et al. Feasibility of remote administration of the Fundamentals of Laparoscopic Surgery (FLS) skills test. Surg Endosc Nov 2013;27(11):4033–7. doi:10.1007/s00464-013-3048-7.

[17] Okrainec A, Henao O, Azzie G. Telesimulation: an effective method for teaching the fundamentals of laparoscopic surgery in resource-restricted countries. Surg Endosc 2010;24(2):417–22. doi:10.1007/s00464-009-0572-6.

[18] Okrainec A, Vassiliou M, Jimenez MC, Henao O, Kaneva P, Matt Ritter E. Remote FLS testing in the real world: ready for "prime time". Surg Endosc Jul 2016;30(7):2697–702 Epub 2015 Nov 18. PMID: 26581618. doi:10.1007/s00464-015-4595-x.

[19] Bailez MM, Maricic MA, Aguilar JJ, et al. Low-cost simulation model for training MIS repair of duodenal atresia combined with telementoring technology: initial assessment. Videoscopy 2016;26(6). doi:10.1089/vor.2016.0381.

[20] Perez Escaraminosa F, Ordorica Flores R, Minor Martinez A. Construction and validation of a low-cost surgical trainer based on iPhone technology for train-

ing laparoscopic skills. Surg Laparosc Endosc Percutan Tech 2015;25(2):78–82. doi:10.1097/SLE.0000000000000134.
[21] Choy I, Fecso A, Kwong J, et al. Remote evaluation of laparoscopic performance using the global operative assessment of laparoscopic skills. Surg Endosc Feb 2013;27(2):378–83. doi:10.1007/s00464-012-2456-4.
[22] Tchantchaleishvili V, Myers PO. Left-handedness–a handicap for training in surgery? J Surg Educ 2010;67(4):233–6 Jul-AugPMID: 20816359. doi:10.1016/j.jsurg.2010.06.001.
[23] Patel SM, Miller CR, Schiavi A, et al. The sim must go on: adapting resident education to the COVID-19 pandemic using telesimulation. Adv Simul (Lond) 2020;5:26 Sep 29. doi:10.1186/s41077-020-00146-w.
[24] Chick RC, Clifton GT, Peace KM, et al. Using technology to maintain the education of residents during the COVID-19 pandemic. J Surg Educ 2020;77(4):729–32. doi:10.1016/j.jsurg.2020.03.018.
[25] Bailez MM, Falcioni AG, Yang HC, et al. Developing a gruyere-like trainer to use in the transition between basic and neonatal simulation-based minimally invasive surgery education. Videoscopy 2019;29(6). doi:10.1089/vor.2019.0583.
[26] Ruiz J, Lopez Imizcoz F, Falcioni AG, et al. Developing simulation models for minimally invasive surgery in pediatric urology. Videoscopy 2020;30(5). doi:10.1089/vor.2020.0678.
[27] Yang HC, Gil Pugliese S, Liñares JM, et al. Developing simulation models for fetal therapy. Videoscopy 2020;29(4). doi:10.1089/vor.2019.0587.