A Novel Resident Colonoscopic Training Approach Utilizing Inanimate, Ex Vivo Animal Tissue and Computer Simulators

Mitra N[1], Nilsson Sjolander E[1], Palacios P[1], Chen YR[1], Carsky K[1], Nussbaum J[1], Riaz A[1], Castro-Otero J[1], Beydoun M[1], Whelan RL[1]

1 - Lenox Hill Hospital, Northwell Health, New York, NY 10028

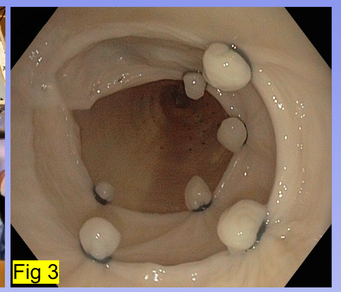
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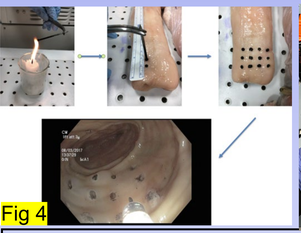
Endoscopic proficiency is mandated by the General Surgery (GS) and Gastroenterology (GI) certifying boards, yet training remains inconsistent due to variability in clinical case volume, training platforms, and limited independent opportunities to perform clinical cases. Traditional clinic based training models rely on case numbers, though research suggests these do not reliably predict competence[1]. Traditional non-clinical training models, including computer-based simulation (CS), lack realistic tactile feedback, particularly in biopsy and snaring techniques, and do not adequately address torque control and loop reduction during insertion. Additionally, endoscopy training often begins at the PGY-3 level, reducing early exposure. To address these limitations, we present a modular training approach incorporating computer simulation, inanimate (IN) and ex vivo large bowel (EVLB) models, designed to introduce foundational skills at the PGY-1 level and then to add additional skills during the PGY-2 to PGY-5 years so that they become competent and proficient endoscopists.

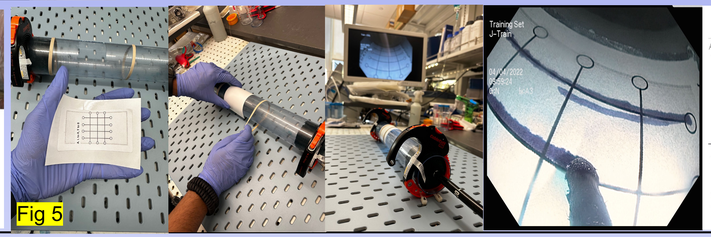


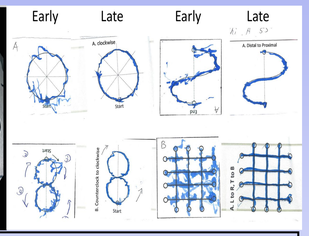
Fig 1


Fig 2


Fig 3


Fig 4


Fig 5



Methods

Our full endoscopic training program consists of **nine structured modules**, targeting both GS and GI trainees:

1. Computer Simulator (CS) – Focuses on scope insertion skills (Fig 1). Three to four different colonoscopies are done.
2. Torque Training (IN) – Task is to touch/mark 3 mm targets dispersed circumferentially in an inanimate tube model. Develops fine motor control to align pathology, reduce loops, and better insert.(Fig 2).
3. Biopsy and Snare Polypectomy (EVLB) – Tattooed targets and pedunculated “polyps” (hemorrhoid bander produced) simulates realistic tissue manipulation and provides experience with biopsy forceps & snares. (Fig 3).
4. Bowel Wall Injection (EVLB) – Injections are made (submucosal is goal) into tattoo targets with sclerotherapy needle and high-pressure catheter (Fig 4).
5. Scope Tip Control and Figure Tracing (IN) – Sclerotherapy “pen” is used to trace line figures (simulates needle knife use) in plastic colon tube model. Teaches control of moving scope tip (Fig 5).
6. Inanimate ESD (Inanimate + animal tissue) – Opportunity to perform ESD using needle knife and dissection cap after lift established. Goal is en bloc removal. Plastic tube with window cutout over which full thickness square of bowel wall and bovey pad are placed.(Fig 7).
7. Hybrid EMR/ESD (EVLB) – Combines needled knife circumferential incision after lift with snare en-bloc and piecemeal resection. More attainable skill set than pure ESD(Fig 8+9).
8. Ex Vivo Large Bowel ESD (EVLB) – ESD in ex vivo large bowel. Most difficult module. Bowel shape and lesion location variable. Requires full skill set (Fig 8+9).
9. Mucosal Wound Closure (EVLB) – Exposed trainees to endoscopic clips and X-tack suturing platform to close mucosal wounds. (Fig 10).

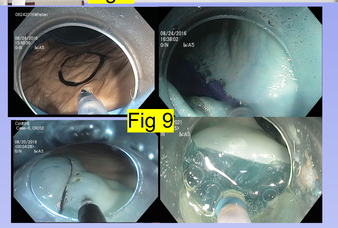
Each session is video-recorded and a dedicated instructor supervises all training except for the CS module. Clinical colonoscopes are used for **Modules 2 and 5**, while **dedicated teaching scopes and towers** are required for **Modules 3, 4, and 6-9**. Five modules focus on a single skill (2-5, 9) and for all modules multiple repetitions of the task are required. Each module emphasizes **repetition and focused skill acquisition**, reinforcing competency at every level.

Results

To date, 20 residents and fellows (Fig. 11) have either completed or are currently enrolled in the program. Performance has been assessed across six modules, while data collection remains in the early stages for the remaining three. Assessment metrics include the number of sessions required to reach a plateau (case length, accuracy, completion of task, etc.), which we think is indicative of skill acquisition. Number of sessions needed are: 1) 6.6 for torque training (Fig 13); 2) 40-60 injections/method for submucosal lift; and 3) 14-16 sessions (8 figures / session) for figure tracing (Fig 12). We believe that 40-60 full ESD cases are needed but have not verified this. (Fig 14). Additional metrics are module specific and include: line figure tracing, deviations from line or gaps in the tracing; Bowel wall injections, accuracy as regards target & type of lift; ESD, en bloc resection, rents, deep wall injuries; mucosal closure, failure to close wound, number of clips/devices.Early findings suggest a reduction in task completion times, along with improved scope handling and procedural accuracy, particularly in scope torque training (Fig. 13), figure tracing (Fig. 12), and ESD case times (Fig. 14). Data collection for the computer simulator, biopsy and snare polypectomy, and mucosal wound closure modules is still in its early stages, making it too soon to draw definitive conclusions.


Fig 6


Fig 7 Fig 8


Fig 9

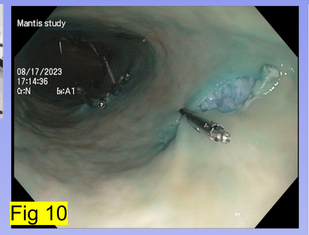


Fig 10

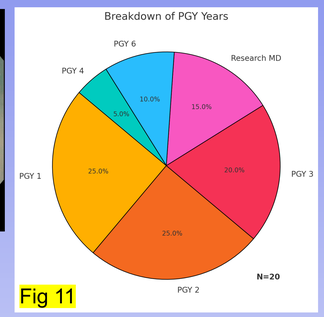


Fig 11

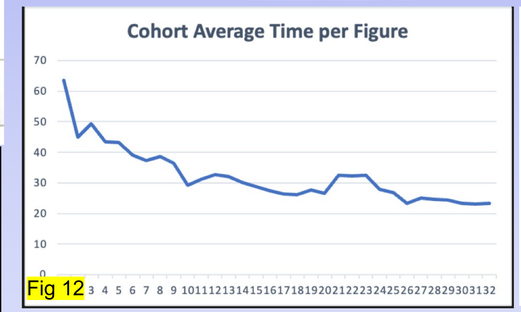


Fig 12

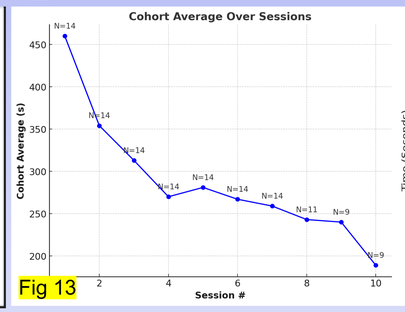


Fig 13

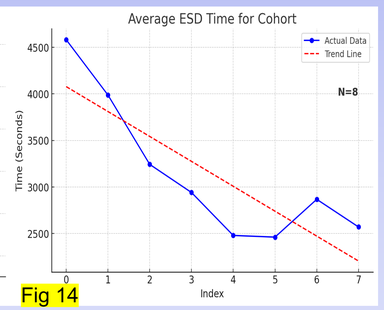


Fig 14

Conclusion

This **comprehensive, modular training program** provides structured, high-repetition practice to build both **fundamental and advanced endoscopic skills**. By introducing **inanimate and ex vivo models**, trainees gain hands-on experience **earlier and more effectively** than through clinical cases alone. Unlike patient-dependent training, this system is limited **only by trainee availability** rather than clinical volume, offering a **scalable and reproducible approach** for endoscopic education. Future studies will examine **long-term retention, clinical application, and expanded trainee cohorts** to validate the model’s impact on real-world endoscopic proficiency.

References

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