

Preserving Cadavers for Endoscopic Surgical Training Purposes: Exploring Cadaveric Training and Virtual Reality (VR) Simulation

The two main pre-requisites for any Endoscopic Surgical Intervention are clinical anatomy and endoscopic surgical training. Endoscopic surgery training is essential for surgical education and skill development that replicates the circumstances faced during actual surgical procedures. There are TWO ways for training; Cadaveric – based Training and Virtual Reality (VR) Simulation. Despite the availability of virtual simulators, holograms, and animal models, hands-on training with actual human cadavers is still preferable for learning and developing medical abilities.

Cadaveric training provides junior doctors with the chance to hone their skills in a realistic anatomical context while, the Virtual Reality (VR) simulation provides an alternative approach that complements cadaveric training, offering a simulated surgical environment for skill development.

This article aims:

1. To introduce Junior doctors, main training methods for endoscopic surgery:
 - o focus on the advantages and characteristics of these methods.
 - o give information on the famous training centers interested with endoscopic surgery.
2. To explain and discuss the subject from the anatomical of view, with pointing to the benefits of these methods (cadaveric training and VR simulation)

1. Cadaveric Training in Endoscopic Surgery:

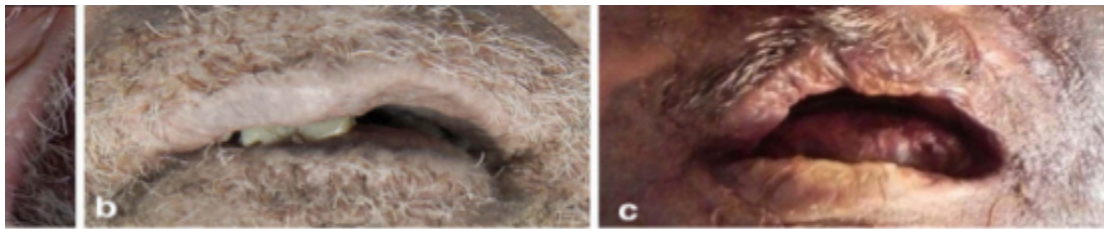
a) Advantages.

1. It provides surgeons with a realistic anatomical representation for practicing various procedures,
2. It allows them to develop their skills in a controlled environment.

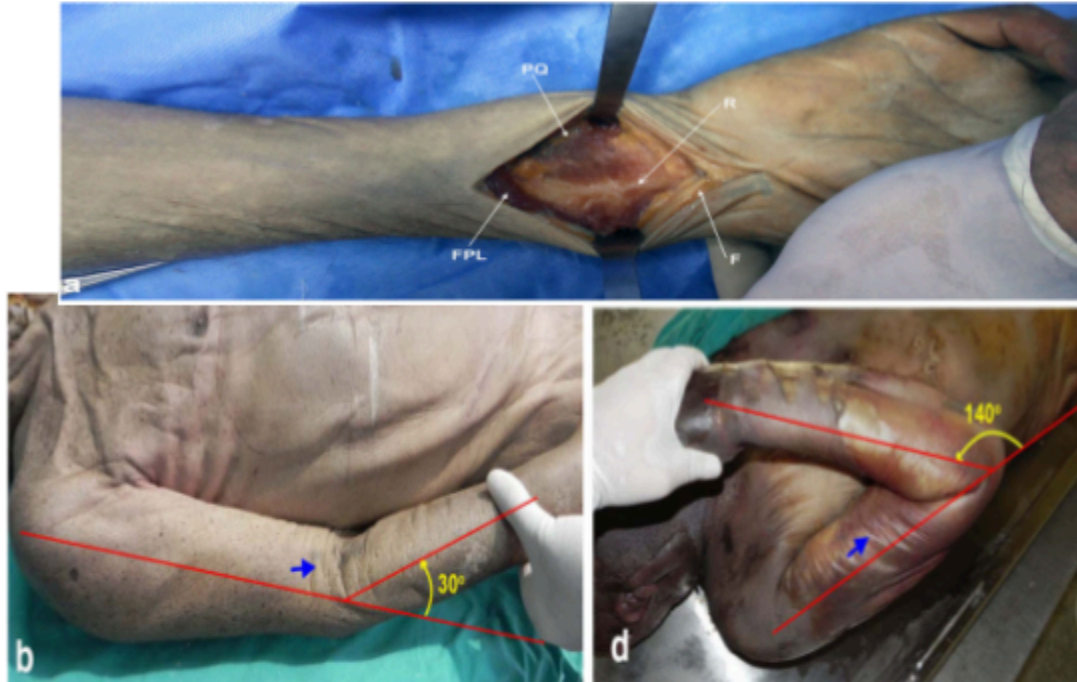
b) Preservative methods:

There are many types of preservatives used in cadaveric training for surgical purposes. These include formaldehyde-based solutions like formalin, Thiel embalming, Silicone-based preservation and Ethanol-based preservation.

The main targets for select the embalming solution are suitable, simple, cost-effective, preserving color, texture, pliability and flexibility of the tissues for a long time without a disturbing smell and mucosal irritation. The best solution has these criteria is **Thiel embalming solution** which is widely used.



b F10-fixed cadaver and **c** MLS-fixed cadaver. *F10* 10% formalin, *FF* fresh frozen, *MLS* modified



Method	Lips and Oral Mucosa Colors	Color of Muscles, Fasciae, Fatty Tissue, Nerves, and Vessels	Bad Smell and Mucosa Irritation	Joint Flexibility and Tissue Pliability
10% Formalin (F10-fixed cadavers)	May cause color changes	May cause color changes	Strong smell and irritation	Reduced flexibility and pliability
Fresh Frozen (FF)	Preserves natural colors	Preserves natural colors	No smell or mucosa irritation	Reduced flexibility and pliability
Larssen Solution	May cause color changes	May cause color changes	Moderate smell and irritation	Moderate flexibility and pliability
Modified Larssen Solution (MLS)	Preserves natural colors	Preserves natural colors	Minimal smell and irritation	Maintains flexibility and pliability
Thiel Solution	Preserves natural colors	Preserves natural colors	Minimal smell and irritation	Maintains flexibility and pliability

i. **Advantages:**

1. Reduces tissue rigidity and discoloration,
2. Enables more accurate simulation of surgical procedures.
3. Preserves the cadaver in a closer resemblance to living tissue, so it allows for improved haptic feedback and a more realistic training experience.
4. Facilitates the manipulation of structures and the demonstration of dynamic movements, so that it enhances the educational value of cadaveric training.

ii. **Disadvantages**, such as:

1. higher cost
2. longer embalming time,
3. needs a specialized expertise.

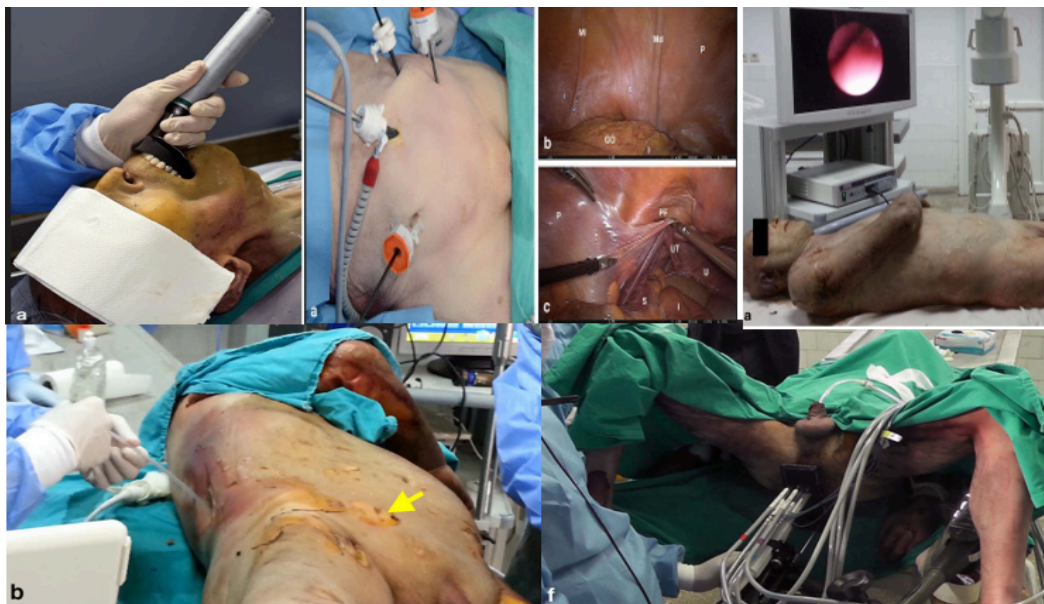
Therefore, Training centers must carefully evaluate their specific needs and resources before choosing the preservation method.

c) **Famous training centers**. include:

1. Cleveland Clinic (<https://my.clevelandclinic.org/>)
2. Mayo Clinic (<https://www.mayoclinic.org/>)
3. Mount Sinai Hospital (<https://www.mountsinai.org/>)
4. Harvard Medical School (<https://hms.harvard.edu/>)

These institutions provide specialized training programs, as well as spaces with cutting-edge technology and qualified instructors, guaranteeing surgeons receive high-quality education.

d) **Types of endoscopic operation that can be practiced**: it enables surgeons to practice a wide range of endoscopic operations, such as:



1. Laparoscopic procedures: Cholecystectomy, appendectomy, hernia repair, etc.
2. Gastrointestinal endoscopy: Esophagogastroduodenoscopy (EGD), colonoscopy, endoscopic retrograde cholangiopancreatography (ERCP), etc.
3. Urologic endoscopy: Cystoscopy, ureteroscopy, prostate surgery, etc.
4. Gynecologic endoscopy: Hysteroscopy, laparoscopic hysterectomy, myomectomy, etc.

2. Virtual Reality (VR) Simulation:

a) Definition:

- o It is an emerging alternative to cadaveric training in endoscopic surgery.
- o It creates a simulated surgical environment using computer-generated graphics and haptic feedback,
- o It allows the surgeons to practice procedures in a virtual setting.
- o It uses computer-generated images rather than real images of the human body. But with the rapid advancements in technology, we suspect improvement of its realism at any moment, to integrate actual patient imaging data for more accurate anatomical representations. **This really happened in the field of radiography**

b) Advantages:

- o Repeatable training scenarios: it permits the surgeons to practice procedures repeatedly, hone their skills and improve performance.
- o Real-time feedback: it offers immediate feedback on instrument handling, procedural accuracy, and overall performance.
- o Cost-effectiveness: it eliminates the need for cadaver procurement, storage, and disposal, reducing associated costs.
- o Remote learning and collaboration: it enables the trainee to access VR training modules from different locations, therefore, it facilitates remote learning and expert guidance.
- o Procedure-specific training: it provides focused training modules for specific endoscopic procedures, allowing the trainee to target his skill development.



c) Famous training centers: include:

- o Osso VR (<https://ossovr.com/>)
- o FundamentalVR (<https://www.fundamentalvr.com/>)
- o VirtaMed (<https://www.virtamed.com/>)
- o Simbionix (<https://www.3dsystems.com/surgical-simulation>)

In-depth VR training courses created for certain endoscopic procedures are available from these facilities. Surgeons may model procedures, practice using virtual tools, and get quick feedback on their performance.

Conclusion

Both the cadaveric method of training and VR simulation play important specific roles. With cadaveric method of training, Junior doctor performs operations and hones his ability in a realistic anatomical setting while, with VR simulation, he gains a replicated surgical setting for targeted instruction and quick feedback.

My Opinion

- o Although, the VR simulation has many benefits in terms of accessibility, repeatability, and cost-effectiveness, it doesn't give the trainee the fully replicate the tactile feedback and complexity of real surgical procedures. Therefore, it can use as a complementary tool rather than a complete replacement to cadaveric training.
- o To increase his knowledge, dexterity, and decision-making ability in endoscopic surgery, the Junior doctor, needs to take integrated method of training (combination of both cadaveric method of training and VR simulation). By this way, a well-rounded educational experience, maximizing training opportunities and improving patient outcomes are provided

Recommendations

- o For our community in Iraq, the best method is the VR simulators. For religious reasons, the Preserving Cadavers is not suitable
- o I recommend to establish an **Endoscopic Surgical Training Center**. For by establishing such centre the junior doctor can gain:
 - a) **Acquirement and refinement** his skills in a controlled and supervised environment.
 - b) **Hands-on experience** in performing endoscopic surgeries.
 - c) **Access to experienced trainers** who can act as mentors and guides.

- d) Well – structured training of junior doctor lead to rise the patient safety as he gets highest quality of care
- e) This centre serves as a hub for
 - i. Interdisciplinary training, promoting collaboration and communication among professionals. This collaborative environment helps in gaining a comprehensive understanding of endoscopic procedures and encourages a holistic approach to patient care.
 - ii. Innovation, providing the junior doctor with updated developments in this field.



Set-up of the tripartite training course:

A: Anatomical and surgical lectures of the anatomical regions and laparoscopic procedures of interest.

B: Interactive demonstration of pre-dissected anatomical specimens by an anatomist (green surgical gown) and surgeon (blue surgical gown) with subsequent hands-on study by the participants.

C: Laparoscopic surgical training on human body donors. Maximum three trainees with one instructor are working in a surgical set-up equipped with a mobile operating table, laparoscopic tower, instruments and energy devices.

D: Intraoperative situation illustrating pelvic lymph node dissection along the right external iliac vessels (Color figure online)