Task-oriented Learning in Head and Neck Anatomy Using Virtual, Formalin-preserved, Soft-embalmed, and Plastinated Cadavers

Ryner Jose D. Carrillo, MD, MSc,[1,2] Karen June P. Dumlao, MD,[1] Jacob Ephraim D. Salud, MD,[2] Eljohn C. Yee, MD,[2] Jose V. Tecson, III, MD, DHPEd[1] and Charlotte M. Chiong, MD, PhD[2,3]

[1]*Department of Anatomy, College of Medicine, University of the Philippines Manila*
[2]*Department of Otolaryngology – Head and Neck Surgery, College of Medicine and Philippine General Hospital, University of the Philippines Manila*
[3]*Philippine National Ear Institute, National Institutes of Health, University of the Philippines Manila*

ABSTRACT

Background and Objective. The COVID 19 pandemic has changed the way the human anatomy is taught. A necessary shift towards online instruction, combined with a decrease in cadaver donation has resulted in the need for maximizing formalinized, soft-embalmed, computerized, and plastinated cadaver specimens. Task-oriented activities allow students to demonstrate acquired knowledge and skills. It is the aim of this study to get the perspective of students in the utilization of available laboratory materials.

Methods. One hundred forty-three students participated in task-oriented activities. Students demonstrated anatomy of the facial nerve, recurrent laryngeal nerve, and phrenic nerve by parotidectomy, thyroidectomy, and posterior neck dissection using formalinized cadaver and VH dissector™. Deep neck and sagittal structures in the plastinated specimen were identified using laser pointers. Ossicular mobility of the middle ear, and endoscopy of the nose and larynx were demonstrated using the soft embalmed cadaver. Students were surveyed on their perceptions on the utility of each cadaver specimen.

Results. Formalinized and soft-embalmed cadaver were observed to present the most accurate anatomy, while the virtual dissector and plastinated specimens were seen to be the most sustainable and reusable.

Conclusion. Task-oriented learning in head and neck anatomy may use different cadaveric materials with varied accuracy and utility.

Keywords: anatomy, cadaver, medical education

INTRODUCTION

Since time immemorial, gross anatomy laboratory dissection used formalinized cadavers, as these provided a robustness for both basic dissection and clinical simulation. However, in recent years, the study and art of human anatomic dissection has evolved to incorporate various teaching methods and technologies that have become more accessible

In 2017, the Department of Anatomy of the UP College of Medicine (UPCM) started to utilize soft-embalmed cadaver using the modified Thiel method to provide flexible human cadaver in demonstrating basic and clinical anatomy in teaching and training.[1-3] This was done in order to augment the modified formalinized cadaver preservation, wherein specimens are generally observed to have limited mobility and flexibility for joint movement, fine dissection, and realistic surgical simulation. The soft-embalmed cadaver

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Corresponding author: Ryner Jose D. Carrillo, MD, MSc
Department of Anatomy
College of Medicine
University of the Philippines Manila
547 Pedro Gil St., Ermita, Manila 1000, Philippines
Email: rdcarrillo@up.edu.ph
ORCiD: https://orcid.org/0000-0003-2439-7682

has been used in teaching medical students, and in training surgical residents for basic and advanced clinical anatomy.

In 2020, the COVID-19 pandemic triggered the use of a modified method of learning in anatomy that limits face to face laboratory dissection. In addition, the supply of cadavers became even more limited due to an increase in cremation practices that was deemed necessary to curb the spread of the virus. To supplement the very limited in-person laboratory teaching of dissection, the Department of Anatomy used the newly acquired touch screen human cadaver dissector table: VH Dissector™ of www.toltech.net. It is a digitized actual human cadaver that is stored as a program in a computer with a touchscreen table interface. This tool allowed online demonstration as well as potential limited face to face dissection during the pandemic.

In 2021, to augment the lack of actual dissection of human specimens, a bridging course in anatomy laboratory dissection was done. It combined the use of the formalinized cadavers, modified Thiel or soft embalmed cadavers, and virtual cadavers in teaching different parts of the human body.

In 2022, plastinated prosected cadaver specimens were acquired as new materials for learning. These are odorless, dry, preserved and hardened cadaver specimen.[4] The plastinated human specimens were predissected to demonstrate anatomic structures.

In the venue of multiple cadaveric materials in learning and demonstrating knowledge in anatomy, the question remains: what is the applicability of plastinated and prosected specimen, virtual human dissector table, soft-embalmed cadaver, and modified formalin preserved cadaver in teaching basic anatomy? In this study, we aim to determine student perception on the usefulness of different types of human cadaveric materials in anatomy by task-oriented activities: identification and pointing of the facial nerve, phrenic nerve, and recurrent laryngeal nerve by defining and measuring adjacent anatomic landmarks, sagittal dissection of the aerodigestive tract, and deep dissection of the infratemporal fossa and neck for arteries and nerves, and lastly, by experiencing cadaveric endoscopy of the nasal cavity, nasopharynx, and larynx as well as the middle ear.

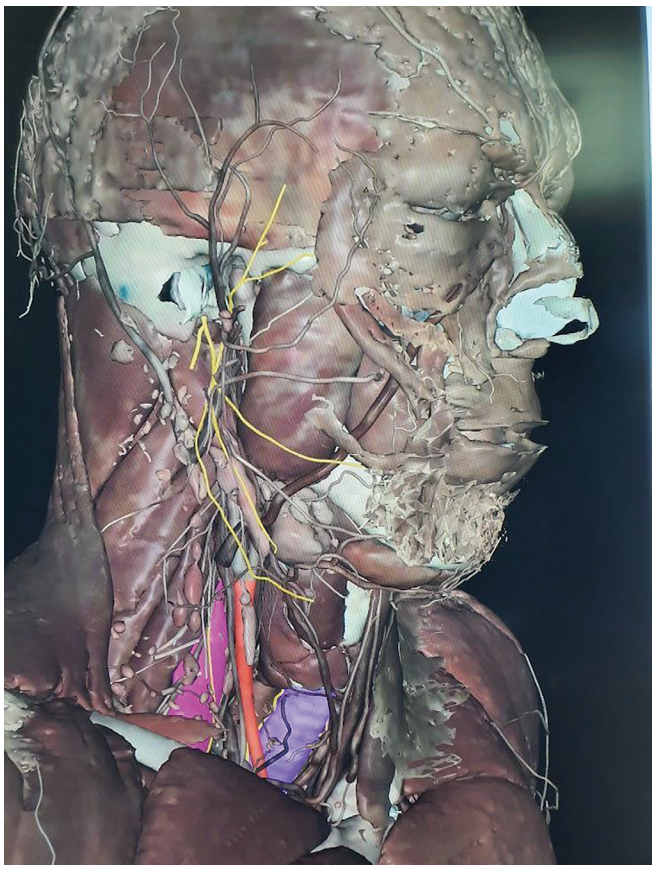

Figure 1. ***VH Dissector™.*** In demonstrating the facial nerve, remove the parotid gland and highlight the main trunk and branches of the facial nerve. In identifying the phrenic nerve, remove the sternocleidomastoid muscle and the jugular veins. Highlight the phrenic nerve and the anterior scalene muscle. In identifying the recurrent laryngeal nerve, remove the thyroid gland, highlight the carotid, trachea, and recurrent laryngeal nerve.

MATERIALS AND METHODS

Learning Enhancement in Anatomy Program 2 (LEAP 2) was held from June 13 to 17, 2022. The activity involved rotation of 200 students in different anatomy laboratory stations represented by different organ system courses (OS), e.g., the head and neck (OS 204), neuroanatomy (OS 202), upper and lower extremities (OS 203), thorax (OS 205), abdomen and pelvis (OS 206), and general histology.

In human body and mind III or OS 204, Head and Neck course, there were task-oriented stations to utilize different anatomic materials during anatomy.

Virtual Dissector Table

VH Dissector™ was presented to the students. They were tasked to dissect and show the facial nerve, phrenic nerve, and recurrent laryngeal nerve with respect to adjacent and removed structures. Students were asked to color highlight the structures. (Figure 1)

Formalinized Cadaver Station

Predissected head and neck formalinized cadaver was presented to the students. The key topics were: facial nerve and branches after superficial parotidectomy, phrenic nerve after neck dissection, and recurrent laryngeal nerve after thyroidectomy. (Figure 2)

Plastinated Models

Plastinated human cadavers are predissected human cadavers that are preserved in a manner where it can be

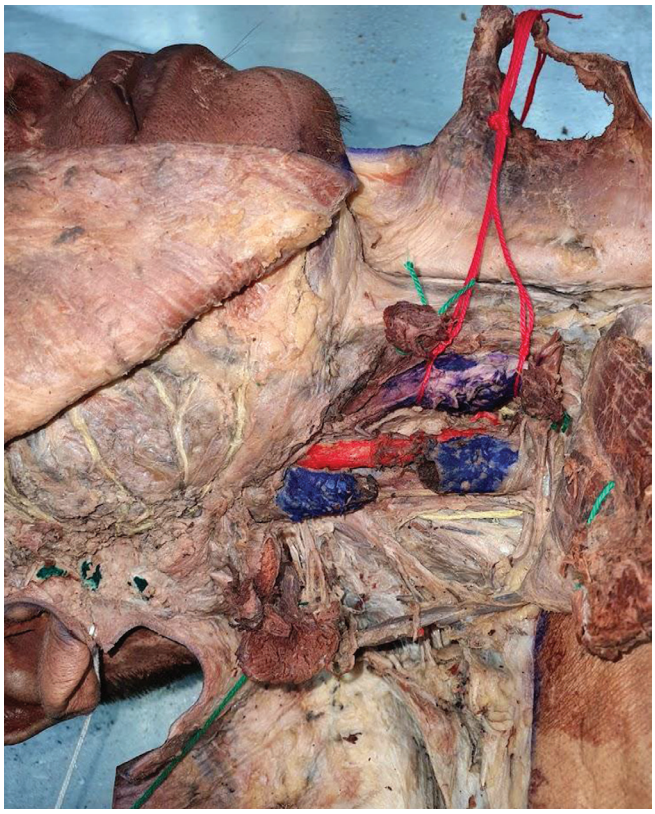

Figure 2. ***Formalinized cadaver.*** Task 1 – measure the main trunk of the facial nerve from tragal pointer, tympanomastoid fissure, and mastoid tip using a caliper. Indicate depth and distance (horizontal, vertical or diagonal distance). Task 2 – identify the phrenic nerve and its relationship with scalene muscles and prevertebral fascia. Task 3 – identify the recurrent laryngeal nerve by reflecting the thyroid gland anteriorly while taking note of the inferior thyroid artery.

odorless, dry, hard, and resilient. It is expensive such that students are allowed to study the specimen using laser pointers only. Students were tasked to point at specific anatomic structures and state functions particularly in the infratemporal fossa and deep neck, and sagittal sections. (Figure 3)

Soft-embalmed (Modified Thiel) Cadaver

The modified Thiel method produces a soft cadaver where structures mirror the fresh cadaver, but with the advantage of a longer preservation. Structures are flexible, and therefore allow maneuvers that are done in actual surgical procedures. The soft embalmed cadaver dissection was set-up to demonstrate middle ear surgery and palpation of the ossicular chain, and direct laryngoscopy and tracheoscopy. Because the set-up required delicate instruments, the first-year students were not allowed to touch the specimen. Instead, they were tasked to identify and annotate structures and relate these to function. They were also tasked to do endotracheal intubation on a cadaver in a suspended laryngoscopy. (Figure 4)

Head and Neck Anatomy Task-oriented Course Survey

A qualitative survey using Google forms and a QR code were given to 180 students participating in LEAP 2. The students were enjoined to validate the utility of the materials used in the bridging course by ticking the characteristics to describe the stations they have rotated in the head and neck course. The characteristics evaluated for each type of cadaver preservation are: accurate anatomy, reproducible activity, reversible dissection, simulates actual size, depth and spatial orientation, touchable, odorless, soft and flexible, likely to provide long term memory, likely to provide skills, likely to promote teamwork, simulate my first patient (allows actual procedure), reusable and sustainable, and versatile.

Figure 3. ***Plastinated Model.*** Task 1 – Using laser pointer, identify and discuss the structures of the nose, pharynx, and larynx. Task 2 – Point at the bifurcation of carotid artery, hypoglossal nerve, vagus nerve, phrenic nerve, and brachial plexus.

RESULTS

One hundred forty-three students out of a total of 180 participants in the Learning Enhancement in Anatomy Program 2 (LEAP 2) took part in the survey. Some students missed the activity because of several reasons including symptomatic COVID-19 infection.

Virtual Dissector (VH Dissector™) Characteristics

The results of the student survey showed that virtual dissectors allowed reversible dissection where structures that had been deleted or removed can be restored. It is reusable and sustainable, but may not simulate the "first patient" or first actual human subject. It is definitely not flexible and does not allow realistic dissection as it does not provide depth and spatial references. (Figure 5)

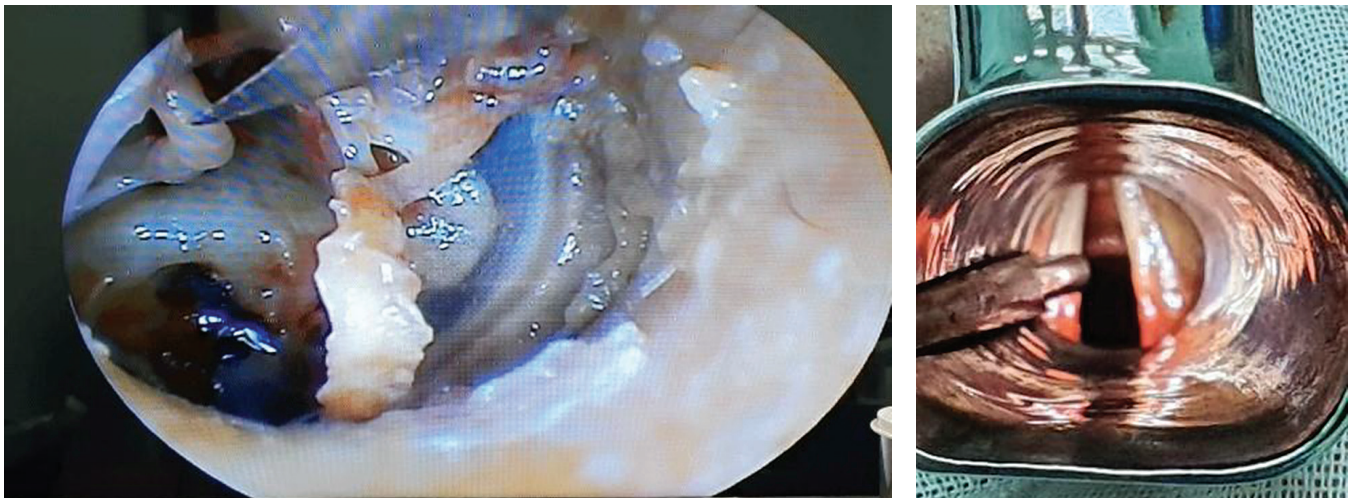

Figure 4. ***Soft-embalmed (Modified Thiel) Cadaver.*** Task 1 – Watch and identify the structures of the nose and nasopharynx, ear and middle ear, and larynx during endoscopy. In the middle ear dissection, observe the ossicular chain palpation and the movement of the fluid over the round window (round window reflex). Task 2 – Insert the endotracheal tube into the suspended larynx. Observe the monitor and annotate. Watch how the endotracheal tube goes through the rima glottidis. Inflate the balloon cuff with air when it is past the level of glottis. While a different laryngoscope is used when doing endotracheal intubation, this demonstrates the laryngeal structures which must be identified during the simulation.

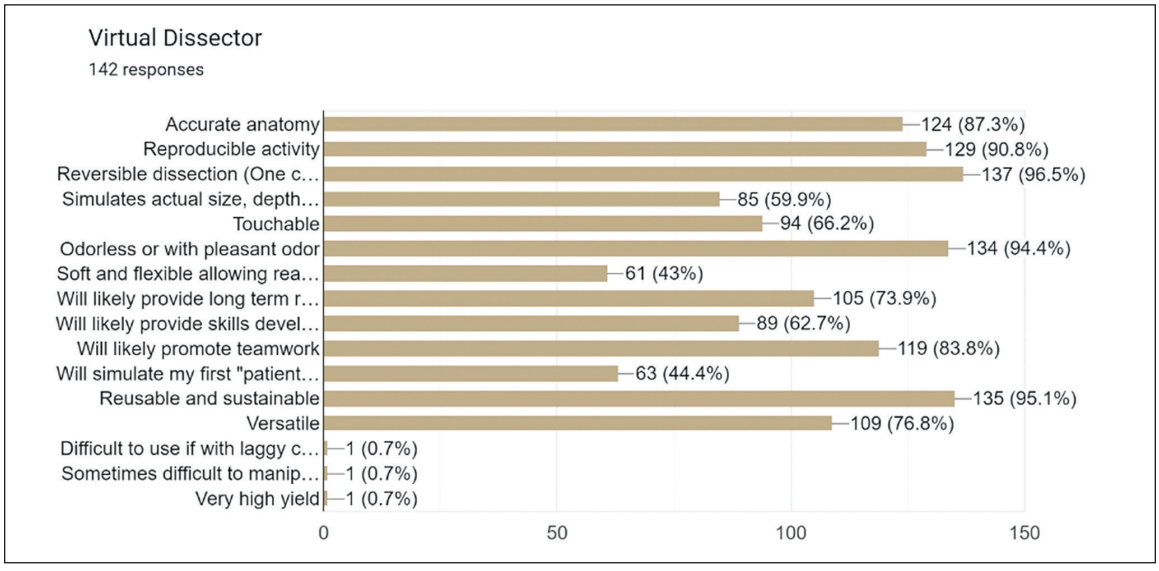

Figure 5. ***Virtual dissector or VH Dissector™ Student Survey.*** For students, the greatest attributes of the Virtual dissector are its reusability and capacity for reversible dissection. The least applicable attributes are the ability to demonstrate soft and flexible structures, and to simulate first patient.

Formalinized Cadaver Student Survey

Modified formalin preservation which used less pungent reagents and fairly soft anatomic structures were predissected and provided to students. Dissecting formalinized cadaver showed accurate anatomy and were also the most touchable. With clear tasks to identify depth and distance from anatomic landmarks, palpating, probing, retracting, and identifying structures provided the most accurate anatomy and touchable set-up during laboratory dissection. This is more likely to produce long-term learning memory. Teamwork was also observed to be facilitated during the dissection process. (Figure 6)

Soft-embalmed (Modified Thiel) Cadaver

The soft-embalmed cadaver had a flexible neck and oral cavity which allowed video-suspension laryngoscopy. Intubation and ventilation were demonstrated. Lifelike middle ear anatomy and ossicular chain mobility were also shown. It provided the most accurate anatomy and skills development based on the survey. However, since the students were not allowed to handle the scope, the station scored low with respect to touchable attribute. (Figure 7)

Plastinated Specimen

The plastinated specimen is a predissected and preserved portion of human specimen. A lot of structures are removed to highlight other anatomic structures and, in this sense, the

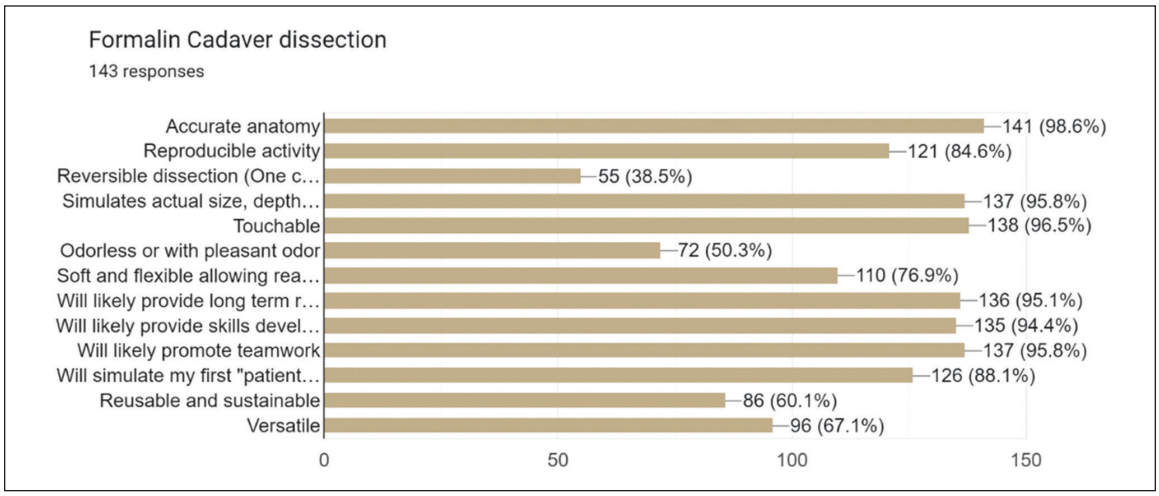

Figure 6. ***Formalinized Cadaver.*** Greatest attributes are accurate anatomy and touchable, while least attributes are reversible dissection and odorless.

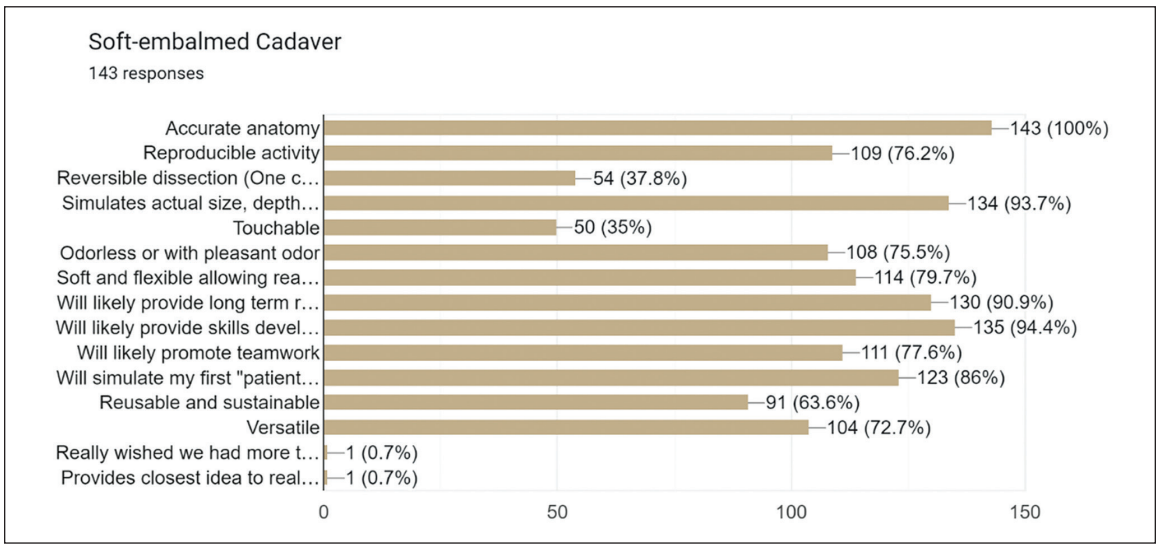

Figure 7. ***Soft-embalmed (Modified Thiel) Cadaver.*** The greatest attributes are accurate anatomy and likeliness to provide skills development. Least attributes are touchable (not allowed to touch the scopes) and reversible dissection.

plastinated specimen is a dissector rendition or artistic version of anatomy. The specimen is odorless, well preserved, and should not decompose. It provides accurate anatomy but has irreversible dissection. Specimens cannot be touched because of the possibility of breakage. Students used laser pointer in studying the plastinated specimen. (Figure 8)

DISCUSSION

Task-oriented Learning

Task-oriented learning in anatomy requires various learning materials as well as teaching methodologies in order to achieve different goals at different levels of learning. In outcome-based learning, first year medicine students have to demonstrate knowledge in basic anatomy and skills in dissecting cadaver. The materials needed to conduct laboratory classes in anatomy must be accurate, reproducible, sustainable, and effective.

A dry, clean, and modern laboratory can be achieved with the use of computerized touch-screen anatomy tables such as VH Dissector™. Students were able to touch the screen in order to open and dissect, color and enlarge, and even return dissected anatomy parts. However, while it is from a digitized 3-dimensional rendering of an actual human cadaver, it is still a 2-dimensional laboratory specimen that is lacking in spatial and tactile references. The computer program and hardware may also require updates in the future. Also, fine structures are difficult to manifest in the VH Dissector™; this is perhaps one of the greatest limitations of the computerized dissecting table. Nevertheless, the use of virtual dissection tables is perceived to have a role in supplementing anatomy education in addition to traditional cadaver-based methods.[5]

The traditional formalinized cadaver dissection allows students to plan incisions, find structures, remove unnecessary soft tissues, and tag key structures of interest. The preservation and storage methods are inexpensive. The students are expected to do a significant amount of work, as well as to devote more laboratory time in its study. It also usually entails division of work and group dynamics. However, due to the pandemic, there is a decreased number of donated cadavers. Hence, there is a direction toward reusable cadaveric specimens after initial dissection until there is an increase in available donated cadavers. This will hopefully be achieved by using immersible prosected cadavers. Modifying preservation methods may also further decrease the smell of cadaver preserved in formalin.

The soft-embalmed cadaver demonstrated flexibility and softness of the cadaver that mimics a fresh cadaver dissection. Nasopharynx and nasal cavity, larynx and trachea, and middle ear structures and ossicular chain movement were demonstrated endoscopically. The flexibility of the neck and the ossicular chain, the softness of the soft-tissues rendered the specimen ideal for simulating the live specimen. However, because the scopes used are expensive, delicate, and require prior training for their use, students were not allowed to touch the instruments, except for endoscope-guided intubation. For future application of the soft-embalmed cadaver, a skill such as intubation and cricothyrotomy are recommended as these are important tasks which can be simulated early on while studying anatomy.

Plastinated specimen are predissected and preserved human specimen. Structures like nerves or vessels are clearly demonstrated because the other intervening soft-tissues are removed already. The plastinated specimen are hard and potentially brittle. It is odorless and likely to last for a long time. However, because the material is expensive, students were not allowed to touch it. It, however, demonstrated spatial and life-size anatomy.

To summarize, the students perceived the different laboratory materials accurate, reproducible, with varied levels of utility for particular tasks. (Table 1)

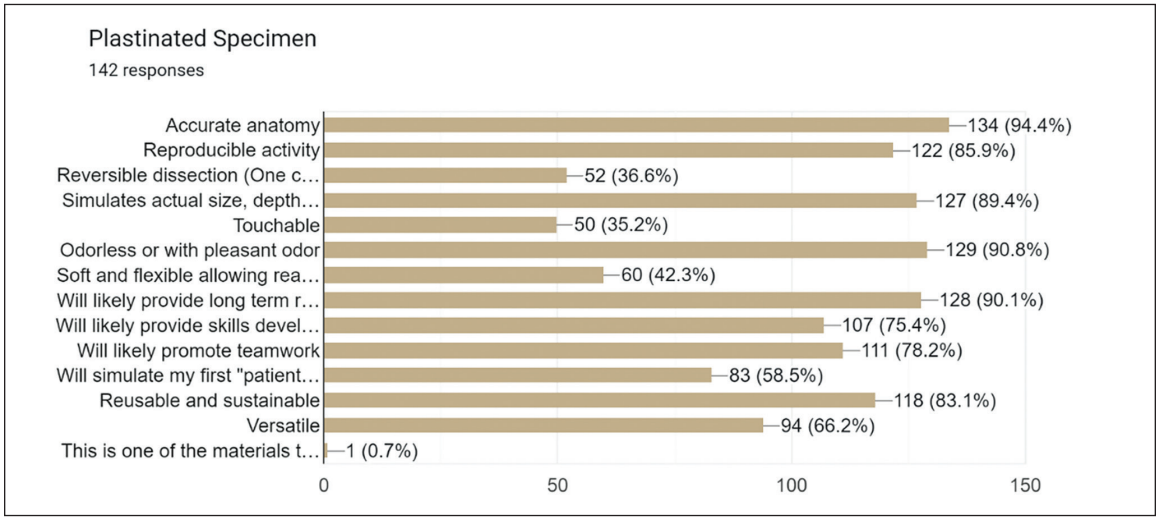

Figure 8. ***Plastinated Specimen.*** Greatest attributes are accurate anatomy and odorless. Least attributes are reversible dissection and touchable.

Table 1. Student Perspective on the Use of Different Anatomy Laboratory Materials

	VH Dissector™ N=142	Formalinized Cadaver N=143	Soft-embalmed Cadaver N=143	Plastinated Specimen N=142
Accurate anatomy	87.3	98.6	**100.0**	94.4
Reproducible activity	**90.8**	84.6	76.2	85.9
Reversible dissection	**96.5**	38.5	37.8	36.6
Simulates actual size and depth	59.9	**95.8**	93.7	89.4
Touchable	66.2	**96.5**	35.0	35.2
Odorless	**94.4**	50.3	75.5	90.8
Soft and flexible	43.0	76.9	**79.7**	42.3
Provides long term memory	73.9	**95.1**	90.9	90.1
Provides skill development	62.7	**94.4**	**94.4**	75.4
Promotes teamwork	83.8	**95.8**	77.6	78.2
Simulates first patient	44.4	**88.1**	86	58.5
Reusable and sustainable	**95.1**	60.1	63.6	83.1
Versatile	**76.8**	67.1	72.7	66.2
Average score	**74.98**	**80.14**	**75.62**	**71.24**

Values are in % agree

CONCLUSION

In task-oriented learning, soft-embalmed and formalinized cadaver are seen to present the most accurate anatomy and flexibility of structures, and produce additional advantages in terms of skills development. The virtual dissecting table and plastinated specimens on the other hand are useful in that they have reusable and sustainable materials. Combining these various teaching materials and methodologies will upgrade and maximize the learning of anatomy for beginning medical students.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

All authors declared no conflicts of interest.

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REFERENCES

1. Grullo PER, Hernando HCT, Carrillo RJD, Villacorta PRF, Hernandez JG, Lopa RAB, et al. Surgical simulation of endoscopic sinus surgery using Thiel soft-embalmed human cadaver. Acta Med Philipp. 2017 Mar;51(1):24-7. doi: 10.47895/amp.v51i1.637.
2. Lacuata JAC, Sarmiento AD, Carrillo RJD. Development of simulation platforms for laser phonosurgery, laryngeal endoscopy, and fiber–carried laser procedures. Acta Med Philipp. 2022 Jun;56(11):31-9. doi: 10.47895/amp.vi0.3055.
3. Villacorta PRF, Hernando HCT, Abdulla AJA, Barroa JKH. A comparative study of Thiel soft-embalmed and formalin preserved cadavers for anatomy dissection. Acta Med Philipp. 2019 Feb;53(1): 12-20. doi: 10.47895/amp.v53i1.235.
4. von Hagens G, Tiedemann K, Kriz W. The current potential of plastination. Anat Embryol (Berl). 1987;175(4):411-21. doi: 10.1007/BF00309677. PMID: 3555158.
5. Chytas D, Salmas M, Noussios G, Paraskevas G, Protogerou V, Demesticha T, et al. Do virtual dissection tables add benefit to cadaver-based anatomy education? An evaluation. Morphologie. 2023 Mar;107(356):1-5. doi: 10.1016/j.morpho.2022.01.002. PMID: 35135673.