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Virtual Cadaver Dissection Prior to Clinical Experiences in Nurse Anesthesia

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Introduction of the Problem

Anesthesia practice requires in-depth knowledge of anatomy and physiology. Therefore, anatomy, physiology, and pathophysiology courses are required in all nurse anesthesia programs. Cadavers have been a mainstay in anatomy education, however, the need for hazardous chemicals, additional space, and maintenance make it difficult for most schools to support traditional cadaver dissection. New virtual dissection tables offer a possible equivalent, yet more sustainable, approach to anatomy instruction. The *Anatomage Table* (AT) allows users to dissect a cadaver that has been scanned and rendered into a three-dimensional (3D) virtual model. The AT is an interactive virtual dissection tool that has additional benefits to traditional cadaver dissection such as replicability, reversibility, organ system isolation, 3D visualization, and opacification of overlying and adjacent structures (Paech et al., 2017). Ultimately, the need to replicate dissection and clinical simulation led a Certified Registered Nurse Anesthesiology (CRNA) program at a Midwestern university to acquire an AT to assist in teaching advanced anatomy.

Prior to the introduction of the AT within the CRNA program at this Midwestern university, Student Registered Nurse Anesthesiologists (SRNAs) were required to perform invasive procedures based on traditional teaching methods such as textbook knowledge of anatomical structures in a two-dimensional format. The AT was introduced to the university's school of nursing as an alternative format for learning human anatomy in a three-dimensional format without the addition of real cadavers. The AT's purpose would serve to improve teaching multiple concepts within the study of anesthesiology. The university did not have the space or

resources to supply and maintain cadavers in a laboratory setting, which is a common issue at many other universities (Sugand, Abrahams, & Khurana, 2010; Wright, 2012).

The clinical applicability and incorporation of the AT has demonstrated the ability to enhance knowledge of anatomy and adjacent structures (Paech et al., 2017). Although extremely limited, trials of successful and effective AT use in nurse anesthesiology programs have been reported (Washmuth et al., 2020). The incorporation of this technology early into an anesthesia curriculum may allow novice practitioners the ability to rotate the human body and view it from a cross sectional perspective. The goals of this project were to integrate virtual cadaver dissection into the nurse anesthesia curriculum and assess student perceptions.

Literature Review

Virtual dissection, such as the AT, could possibly bridge the gap between teaching without cadavers while adding all of the same concepts and additional features to dissection, such as opacity of structures and replicability of dissection. Many of these newer aspects provide perspectives that are not possible with traditional manual dissection (Paech et al., 2017). Brucoli et al. (2019) stated that the comprehension of complex pathologies was an important concept and helpful for inexperienced surgeons during complicated cases and the AT could help fill this gap of knowledge.

Fyfe, Fyfe, and Dye (2013) evaluated the use of an AT in a first-year health sciences program. The AT replaced cadaver dissection in their program due to increased class sizes and cost. Three-hundred twenty-six students worked in groups of eight with tutors during weekly workshops. Students completed a survey after use of the AT and reported several positive aspects of virtual dissection such as more advanced comprehension of structure size in relation to

other structures, revealing underlying anatomy by use of the dissection tool, and learning the correct names for specific structures with the labeling tool.

Studies have been conducted to evaluate the impact of AT on anatomy education. Five hundred eleven medical students participated in a study to determine their perceptions of AT. Of the participants involved, 63% strongly agreed that AT use significantly improved their understanding of 3D anatomy and 78% strongly agreed that the interactive nature of the AT made learning anatomy more engaging (Brown, & et al., 2015). Paech et al. (2017) evaluated the use of an AT by comparing three cohorts of students (n=238), with only one group having access to an AT. Students with access to the AT had significantly higher gross anatomy exam scores compared to the two other groups ($p<0.001$). Of the 49 respondents with access to the AT, 87.8% agreed that virtual reality was a positive adjunct to first-year gross anatomy 89.8% were able to recognize anatomical structures on imaging data, and 85.4% stated that it was sensible to learn how to read radiographic scans as novice medical professionals (Paech et al., 2017). A study conducted at SIUE by Smith, Ruholl, & Gopalan (2019) prior to this DNP project produced similar results. Within the study, surveys were conducted which explored perceptions of the AT following completion of an initial 2-week student clinical rotation. Students (n=17) were asked open-ended questions concerning the impact of virtual dissection on their clinical experiences. Many common themes were identified in the responses such as "The AT reinforced classroom concepts as a visual aid. When asked questions in clinical I had a mental picture of what they were asking me" and "I felt more confident in stating what anatomy I was seeing or feeling with my clinical preceptors" (Smith, Ruholl, & Gopalan, 2019).

Precise knowledge of three-dimensional anatomy is essential to the ability to provide Ultrasound-Guided Regional Anesthesia (UGRA), a core skill of anesthesia practice. One of the

primary benefits of the AT is that each cadaver has the ability to be rotated in a three-dimensional view to help learn cross sectional views that are used to interpret ultrasound imaging. Gasko et al. (2012) enhanced UGRA training with virtual simulation using various software. Thirty-three participants from a CRNA program were selected to participate in this study. Results from repeated measures post hoc analysis indicated that the combination of human simulation and CD-ROM virtual simulation were significantly better at increasing performance of UGRA than the CD-ROM virtual simulation or human simulation alone ($P < .05$) (Gasko et al., 2012).

Overall, low-level evidence suggests that virtual dissection, such as the AT, is thought to be a useful adjunct for learning anatomical structures in the early didactic courses of study among multiple medical professions. Virtual simulation is an effective way to evaluate student performance (Lui et al., 2018). There are key advantages and disadvantages between traditional and virtual cadaver dissection, however, neither has proven to be superior (Wong, 2014). However, most participants using any form of virtual dissection agree that its relevance to practice, and its ability to enhance anatomical knowledge, are unquestionable. Evidence suggests the incorporation of ATs in various medical professions have shown applications that apply to all aspects of anesthesia studies.

Project Methods

The ultimate intent of this project was to enhance a smooth introduction of AT technology into a midwestern university School of Nursing Anesthesiology curriculum in a way that was conducive to student learning. The goal was to improve students' understanding of anatomy and also to train students in the independent use of the AT. The university obtained the

AT to replicate cadaver dissection for anatomy-focused course curriculum. The beginning of this project involved obtaining Institutional Review Board (IRB) approval to involve human subjects. IRB #681 was approved on January 17th, 2020 as a quality improvement project.

Twenty-four first year Student Registered Nurse Anesthetists (SRNAs) enrolled in an introductory nurse anesthesia course at a university in the Midwest participated in this pilot study. These students had taken anatomy and physiology courses as prerequisites but did not have exposure to the AT prior to this course. The university had purchased an AT to facilitate teaching within the School of Nursing but had yet to embed its use into anesthesia coursework. The authors created surveys, user manuals, and lessons to help introduce and implement the AT into this course.

An anesthesia-specific student user manual was created with two separate self-guided lessons that focused on respiratory anatomy and neuraxial anatomy. Three surveys were created by two SRNAs who collaborated with CRNA faculty to enhance and improve the deployment of teaching with the AT in the curriculum. All students attended two sessions held one month apart, one session covered respiratory anatomy while the other covered neuraxial anatomy. Sessions were one hour long and conducted in small groups of 4-6 students, allowing each student quality hands-on exposure to the AT and time for follow up questions. After both sessions, participants were encouraged to use the AT during open lab time. Participants were given 3 separate online surveys, one immediately after orientation to the AT, a second survey after completion of the course and prior to clinical experiences, and a third survey following the initial student clinical rotation. The surveys gathered data regarding student perceptions related to the use of the AT within didactic coursework. Subjective data gathered from surveyed participants was used to make changes to enhance AT training tactics within the Nurse Anesthesiology program.

Evaluation

Surveys

Three separate online surveys were created by the authors and conducted with one SRNA cohort (n=24) to measure user confidence, perceptions of AT use in anesthesia curriculum, and advantages or barriers to independent use of the AT. The first survey was administered immediately following the initial AT session and included 5 Likert scale questions to measure user confidence in AT operation and the likelihood of independent student use. Seventeen students completed the survey and all (n=17; 100%) strongly agreed, agreed, or somewhat agreed that they planned to use the virtual cadaver dissection during open lab hours. Most respondents (n=16; 94%) were confident in the use of the AT following the initial session. One question was asked on ideal group size for instruction. Respondents reported groups of 2-3 or 4-5 participants to be ideal for the learning environment.

The second survey was administered following completion of the semester didactic course and immediately prior to initiation of clinical rotations; twelve students completed the survey. Three questions measured user confidence in independent AT operation, relevance to didactic content, and perceived benefits and barriers to AT use in a Likert scale format. Most respondents (n=8) still agreed or somewhat agreed that they were confident in AT use following the second instruction session. Also, all respondents (n=12) strongly agreed or somewhat agreed AT use was relevant to didactic content. Students were asked how much time they thought they would have spent using the table if COVID-19 shutdowns had not occurred (mean = 4.3hours). The survey also included 3 open-ended questions about usefulness and barriers. The common themes of barriers presented as a lack of time and operating software, and useful aspects including 3D views and gross anatomy overview.

The third survey re-explored perceptions of the AT following completion of the initial 2-week student clinical rotation. Seventeen respondents completed the final survey. Seven questions were asked concerning performance of AT use as well as confidence in identifying anatomy in the clinical environment. Students were asked 5 open-ended questions concerning the impact of virtual dissection on their clinical experiences. Most open-ended responses followed general themes that the AT "Increased my confidence in knowing the anatomy of my patients" and that it "Reinforced classroom concepts as a visual aid" "When asked questions in clinical, I had a mental picture of what they were asking me". Common drawbacks to the AT were needing more training to use software and needing more time to utilize the AT during open lab time.

Outcomes

According to the surveys, SRNAs described overall positive experiences with the AT and reported it had a positive impact on their first clinical experiences. More specifically, participants reported increased ease in identifying airway and neuraxial A&P in the classroom and clinical settings, assistance with didactic coursework concepts, and expanded comprehension of anesthesia procedures after using the AT. Students reported the negative aspects of the AT were large group sizes limiting hands-on access to the table, accessibility with time constraints within the University's operating hours, and the initial lack of confidence in operating the AT independently. Modifications to AT implementation were made by faculty to address negative student perceptions toward the use of the AT. Many changes occurred to AT use after each survey evaluation. Some of the changes were user group size limits, hours of operation, accessibility to the AT, provision of anesthesia related topics to focus on, and overall mandatory lab times designated to AT use. The changes were made to create a user-friendly environment to accommodate for future cohorts.

Limitations

Project implementation began in Spring 2020 when COVID-19 began shutting down normal operations at the university. Originally, the authors planned on conducting 3 implementation sessions with the entire cohort but were only able to accomplish 2 sessions before classwork was moved to an online format. Access to the AT was restricted for the rest of the semester. The cohort also began their first clinical experiences later than expected due to COVID-19, thus the time between interaction with AT and the start of clinical was greater than expected. The students started their clinical experiences at various times, thus the time from interaction with the AT to the first clinical experiences varied slightly.

Impact on Practice

Initially, students did not use the AT because none of the university faculty could effectively operate AT software. The AT's application to teaching anatomical concepts related to anesthesia was redirected toward topics that peaked student interest and imbedded in anesthesia curriculum. To increase satisfaction and provide a better hands-on experience, group sizes changed from whole cohorts to groups of no more than 2-6 students at a time. Nurse Anesthesia faculty who teach and professionally practice in various subspecialties of anesthesia within the program now utilize lab simulation time to teach key points of anesthesia topics with the AT in a small group format. In the future, the table will be used for additional anesthetic concepts such as regional anesthesia to reinforce anatomical knowledge of central and peripheral nerve blocks. To maximize the use and effectiveness of the AT, student feedback should be collected each semester.

Conclusions

The purpose of this study was to explore student perceptions related to AT implementation into the SRNA didactic curriculum at a university in the Midwest. Compared to an interactive three-dimensional model, standard textbook images have many limitations. The AT is a new technology that has not been studied in depth. Many computer-based resources are used to teach anatomy; however, few studies have made a comparable analysis of these resources to traditional teaching methods. Additional studies are needed to determine if the AT is an effective learning tool compared to traditional methods. Data from this study suggests students perceive the AT as an effective alternative to traditional teaching techniques to improve anatomy comprehension for anesthesia care. The potential to add numerous training topics and guides to didactic coursework are endless among various topics of anesthesia. Quizzes for gross anatomy are possible with AT software along with many radiographic alternative case studies. Continual assessment and evaluation of student preferences should be considered to continue enhancing AT use within the curriculum.

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