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Anatomical and Clinical Education in Physical and Occupational Therapy: Influence of Integration and Soft Preservation

Educación Anatómica y Clínica en Terapia Física y Ocupacional: Influencia de la Integración y la Preservación Blanda

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SUMMARY: Anatomy and clinical skills are taught separately to physical and occupational therapy students. Formaldehyde is the primary chemical used to embalm donors which creates a challenge in integrating clinical skills into the anatomy curriculum. This study aimed to evaluate the integration of clinical skills into anatomical education using Imperial College London- Soft Preservation (ICL-SP) and formaldehyde embalming through the evaluation of student perceived learning and confidence. Students were invited to complete a survey after dissecting an ICL-SP and formaldehyde embalmed donors and perform clinical tests. It was easier to dissect and identify neurovascular structures on ICL-SP donors compared to formaldehyde. Clinical tests, like measuring range of motion and ligament tests were also more realistic on ICL-SP donors. The integration of clinical skills in the anatomical curriculum increased student perceived understanding of associated anatomy ($p < 0.001$), gave better understanding of how anatomy is important to their professions ($p < 0.001$) and increased motivation to learn anatomy ($p < 0.001$). The integration of clinical skills into anatomical education can facilitate student learning with higher confidence performing clinical skills and is complemented by the utilization of the new ICL-SP methodology instead of the traditional formaldehyde preservation.

KEY WORDS: Anatomy; Physical Therapy; Occupational Therapy; Education; Soft Preservation; Integrated Curriculum.

INTRODUCTION

The teaching of anatomical sciences varies based on educational program and country but has significant overlap based around a didactic curriculum involving both a lecture portion and anatomical laboratory portion (Drake *et al*., 2009). These courses traditionally utilize both written examinations to evaluate lecture-based learning, as well as laboratory practical assessments to evaluate laboratory-based learning with some overlap to illustrate integration of material.

The teaching of anatomy within the laboratory component utilizes many strategies to illustrate anatomic structures, relationships, and functions. Anatomical Knowledge is essential in many allied health sciences such as those who practice physical and occupational therapy. Within these programs, many incorporate anatomy early in the curriculum and typically are comprised of lecture and human donor dissection components (Mattingly & Barnes, 1994; Drake *et al*., 2009). Most anatomy courses are taught as a standalone course and do not have a significant integrated curriculum (Drake, 1998; Drake *et al*., 2009; Krause *et al.,* 2011).

The process of dissection of human donors has been described as the most beneficial method for the teaching of anatomical structures due to the visualization of the three dimensionality and spatial relationships of the human body (McLachlan *et al*., 2004; Patel & Moxham, 2008; Ghosh, 2017; Balta *et al*., 2019). In addition to increased anatomical competencies, dissection allows for a better understanding of technical terminologies, practice of technical skills and interactions with ethical aspects of death that allows for a

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potential increase in empathy and coping strategies while also giving a better understanding of dignity, consent and the difference of objectification and personification (Estai & Bunt, 2016; Ghosh, 2017; Iwanaga *et al*., 2021).

Since its discovery in the 19th century, formaldehyde injection into the arterial system has been one the most utilized embalming techniques within medical and allied health education (Piombino-Mascali *et al*., 2009; Trompette & Lemonnier, 2009; Brenner, 2014). It is important for the embalmed tissues to retain the characteristics of the non-embalmed tissues, such as flexibility and color while slowing tissue degradation and decreases in potential infectious nature (Balta *et al*., 2015). This goal is not sufficiently met through the current utilization of formaldehyde (Hubbell *et al*., 2002). Despite its tremendous antimicrobial abilities, formaldehyde has many limitations and health concerns. Formaldehyde as an embalming fixative has been shown to decrease joint flexibility, decrease musculature color and hydration, present an unpleasant odor and a potential carcinogenic effect (Richens *et al*., 1963; Athanassiadis *et al*., 2015; Balta *et al*., 2015, 2019).

Many soft preservation techniques have been reported in the literature such as Thiel, Saturated Salt and the Imperial College London-Soft Preservation (ICL-SP) which has shown immense potential as an alternative to traditional formaldehyde preservation. ICL-SP was first described in 2009 and is a soft preservation method and consists of alcohol, water, glycerol, and phenol (Barton *et al*., 2009; Balta *et al*., 2019). In terms of presentation of anatomical structures, embalming with formaldehyde causes enlargement of highly vascularized internal organs such as the heart, lungs, and liver due to injection of solutions expanding these vessels and the formaldehyde fixative agents causing fixation in this state, specifically in the thoracic and abdominal regions (Balta *et al*., 2019). This finding was not seen in ICL-SP donors. Additionally, Balta *et al*. (2019) showed that ICL-SP minimally affects joint range of motion. This, coupled with fewer associated health concerns, shows potential of ICL-SP as a viable alternative to formaldehyde within academia even though embalming using this technique comes at a slightly higher financial cost (Balta *et al*., 2019).

Meanwhile, when it comes to clinical skills education, the most widely utilized methodology is the idea of "see one, do one, teach one" (Vozenilek *et al*., 2004). Clinical skills are typically taught in a separate part of the curriculum than the anatomy education. The "see one, do one, teach one" method has been critiqued by many because the students do not have the chance to conduct the skills on non-living individuals or objects (Akaike *et al*., 2012; Sawyer *et al*., 2015). Simulation-based medical education is a teaching method that allows students to learn the associated skills within a controlled environment that does not involve living patients (Akaike *et al*., 2012; Sawyer *et al*., 2015). This allows for the incorporation of a "learn" step prior to performing the skill. This step can utilize plastic models, human donors, and even virtual reality (Akaike *et al*., 2012). The implementation of this step allows the student to show competency prior to performing the procedure on a human patient (Sawyer *et al*., 2015).

While there is some evidence that that the inclusion of anatomy curricula into skills-based coursework can enhance learning of the skills, increase confidence in performing the skill, and increase confidence in anatomical retention (Krause *et al*., 2011). There is also evidence that the integration of clinical skills in conjunction with the gross anatomy coursework results in better performance on anatomical examinations and better performance of clinical skills (Dasseau *et al*., 2008).

To date, there is no published research regarding the learning and dissection experiences while utilizing ICL-SP technique along with integrating clinical skills. Thus, this study aimed to (1) evaluate physical therapy and occupational therapy students' attitudes towards dissection experience of formaldehyde and ICL-SP embalmed donors, (2) evaluate the integration of clinical skills within the anatomy laboratory, and (3) evaluate if one preservation method is more advantageous in relation to learning of clinical skills and perceived anatomical learning.

MATERIAL AND METHOD

Participants. This study had a sample of ninety-eight (98) students enrolled in the Musculoskeletal Anatomy course offered to physical and occupational therapy students at The Ohio State University. This course is in the first semester of the planned curriculum. No participant that began this study was excluded from the final research analysis. Participants were able to opt out of data collection at the end of the final laboratory period of the course. Once data collection was completed participants were no longer able to withdraw from the study due to all data being deidentified and researchers were not able to correlate data to any individual participant.

Study Design. Participants were randomly assigned to dissection groups, beginning with either an ICL-SP embalmed donor (group A) or a formaldehyde embalmed donor (group B). Participants underwent the first division of the course which relates to the anatomical structures of the lower limb and pelvis. During the final laboratory of the

first division, participants were instructed on how to measure dorsiflexion and plantar flexion range of motion using hand-held goniometers. During this laboratory, participants were also instructed on how to perform the Lachman's test of the knee. The Lachman's test of the knee is commonly performed to evaluate the integrity of the Anterior Cruciate Ligament. Participants were instructed to perform both the range of motion and the ligament testing on both types of donors; ICL-SP and formaldehyde.

After the first division, participants underwent written and practical examinations over the first division materials. At the conclusions of these examinations, the participants were assigned to a new donor belonging to the opposite embalmed donor type utilized in the first division. This means, group A began to dissect on formaldehyde donors and group B dissected ICL-SP embalmed donors. The dissection groups remained the same.

The second division of the course began after the first written examination and laboratory practical. Division II relates to the upper limb, back, and pectoral region. During the final laboratory of the second division, participants were instructed to examine wrist radial and ulnar deviation range of motion using hand-held goniometers. During this laboratory, participants were instructed to perform the valgus stress test of the elbow. The valgus stress test is commonly used to evaluate the integrity of the Ulnar Collateral Ligament. Participants were instructed to perform the range of motion and ligament testing and on both ICL-SP and formaldehyde embalmed donors.

Immediately following the last laboratory session of the second division, the research team entered the laboratory and outlined the study and IRB consent forms. The course instructors were asked to exit the laboratory and the research team distributed and gathered the signed informed consent forms from those who wished to participate in the study. After signed consent forms were collected, the participants were asked to complete a brief anonymous questionnaire regarding their experience in the laboratory concerning dissection, range of motion testing (ankle dorsiflexion/ plantar flexion; wrist radial and ulnar deviation), special clinical testing (Lachman's test of the knee; valgus stress test of the elbow) and perceived impact on anatomical knowledge. All information on the questionnaire was consolidated and statistically evaluated.

Questionnaire Design. A singular questionnaire (Appendix 1) was administered to evaluate 1) demographics of the sample, 2) comparison of dissection experience between embalmed donor types, 3) comparison of confidence and experience performing range of motion testing between embalmed donor types, 4) comparison of confidence and experience performing special clinical testing between embalmed donor types, 5) student opinion on the effect of integration of clinical testing and its influence of their anatomical knowledge. All questions for sections two, three, four and five utilized a five-point Likert scale format. This allowed for the questions to be scored on a 1-5 scale.

For questions in the dissection experience portion of the questionnaire students were asked to rate the ease of dissection and identification of various anatomical areas with 1= very difficult and 5= very easy. Additionally, in the dissection experience portion, students were asked for their opinion of certain given statements with 1= strongly disagree and 5= strongly agree. Students were asked to evaluate these statements for both donor series A and B.

The questionnaire sections covering the range of motion and clinical testing experience followed a similar Likert scale, where students were presented with a statement, and they had to rate their level of agreement with 1=strongly disagree and 5= strongly agree. Students were asked to evaluate these statements for both donor series A and B. These areas also had students give their opinions on which embalming style was more beneficial to their experience performing range of motion and clinical testing utilizing a Likert scale where 1= Alcohol (donor series A) was best and 5= Formaldehyde (donor series B) was best.

The final section covering student perceptions of integration affecting anatomical knowledge, students were presented with statements such as "Completing the valgus stress test of the elbow increased my understanding of the UCL and its function" and "The integration of the clinical tests increased my motivation to learn anatomy" and were asked to score their agreement utilizing a five-point Likert scale where 1= strongly disagree and 5= strongly agree. At the end of the questionnaire, participants were provided a space for extra comments.

Statistical Analysis. Summary statistics on demographics were compiled and computed utilizing Microsoft Excel. The statistical package "R" was used to analyze all numerical findings. All Likert-scale questions were scaled to numerical values ranging from one (1) to five (5). Data from the two groups were combined based on question. Utilization of the random assignment into groups was to prevent the influence of acquired proficiency in dissection during the course, so separation of data is not necessary. Initial grouping of participants was not reported.

Questions evaluating student opinions on ICL-SP and formaldehyde fixation were independently compared

utilizing a two-sample t-test to generate a p-value that was evaluated at a 95% confidence level to determine significance. Null hypothesis for these tests was the assumption of no difference in opinions between groups. Additionally, both ICL-SP and formaldehyde questions had basic descriptive statistics such as means calculated. These data met the criteria to be deemed parametric, justifying the use of a two-sample t-test.

Questions that directly compared ICL-SP and formaldehyde fixation underwent one-sample t-test to generate a p-value that was evaluated at a 95% confidence level to determine significance. The null hypothesis for these t-tests were assuming no favoritism between embalming type (i.e., Likert score=3). Additionally, the mean for questions directly comparing embalming types were generated. These data met the criteria to be deemed parametric, justifying the use of a one-sample t-test

Evaluation of the student background potentially influencing other questions was assessed. The potential impact of student undergraduate major and prior utilization of human donors on the dissection experience was analyzed utilizing an analysis of variance (ANOVA) to generate a p-value that was evaluated at a 95% confidence level to determine significance. Any statistically significant ANOVA test were subjected to the Tukey's post hoc analysis to determine what group may show significant differences compared to the others. The potential impact of student professional program (physical therapy or occupational therapy) on dissection experience, range of motion assessment, clinical testing and anatomical knowledge questions was assessed utilizing a Welch two-sample t-test to generate a p-value that was evaluated at a 95% confidence level to determine significance. These data met the criteria to be deemed parametric, justifying the use of a Welch two-sample t-test and ANOVA followed by post hoc analysis where applicable.

Ethical Approval. All personal identifiers were removed from data set prior to analysis. All data were compiled utilizing Microsoft Office Excel. Ethical approval was gained for this research study by the Intuitional Review Board (IRB) at The Ohio State University under the study number 2021E0469.

RESULTS

Participant Background. From the invited participants, 63 (86 %) completed the questionnaire in its entirety and an additional 10 (14 %) participants submitted the questionnaire in its entirety but did not differentiate which embalming type they were rating. Meaning that the only viable information from these participants were demographic information and opinion on the integration of clinical skills into anatomical curricula as they were not dependent on embalming types. Summary of this demographic section are displayed in Table I.

Dissection Experience. Participants noticed no difference in dissection difficulty between embalming types, but there were significant differences in identification of structures (Table II). Participants found it easier to identify portions of the vascular and nervous systems in ICL-SP donors compared to the formaldehyde donors while showing no difference in identification of musculature between embalming types.

Participants reported that the appearance of the ICL-SP donors made them more uncomfortable than formaldehyde donors and was accompanied by increased feeling of discomfort during dissection (Table III). Participants believed that ICL-SP and formaldehyde donors resembled the images presented during the course and the participants did not believe one preservation type better aligned more with the images than the other. The odor of the ICL-SP alcohol fixative showed no significance compared to the odor of the formaldehyde. Though there was no significant difference in perceived benefit in learning of anatomical structures, participants believed that the ICL-SP donors had a more similar range of motion to that of the average individual than formaldehyde.

During the open response portion of the questionnaire, participants shared comments on how ICL-SP donors had structures that were more easily differentiated, but the preservation was more variable (Table IV).

Dissection experience was assessed based on participant undergraduate major, current professional program, and prior experience utilizing human donors.

Table I. Student demographics.

Demographic Statistics				
Sex	Male: 12%		Female: 88%	
Academic Program	Physical Therapy: 49%		Occupational Therapy: 51%	
Age	21-25 Years Old: 94%	26-29 Years Old: 3%	30+ Years Old: 3%	
Previous Donor Experience	No Experience: 40%	Dissection Only: 30%	Prosection Only: 10%	Prosection and Dissection: 20%

Table II. Students' perspectives on the ease of identification and dissection of donors on a Likert scale with "very difficult" represented as "1", neither easy or difficult represented as"3" and "very easy" represented as "5"

Associated Question	Formaldehyde Mean	ICL-SP Mean	*p*-Value
Ease of vasculature identification	3.19 ±0.91	3.81 ±1.00	0.002*
Ease of nerve identification	3.40 ±0.89	3.79 ±0.95	0.027*
Ease of musculature identification	3.84 ±1.00	3.70 ±1.29	0.540
Ease of vascular dissection	3.32 ±0.88	3.43 ±0.97	0.462
Ease of nerve dissection	3.30 ±0.84	3.47 ±0.92	0.344
Ease of musculature dissection	3.66 ±0.81	3.41 ±1.16	0.189
Ease of dermis dissection	3.61 ±1.01	3.63 ±1.11	0.737

*p-value is significant tested as a 95% confidence level.

Table III. Students' opinions on their dissection experience when working with both formalin and ICL-SP embalmed donors using a Likert scale with "strongly disagree" represented as "1" and "Strongly agree" represented as "5"

Associated Question	Formaldehyde Mean	ICL-SP Mean	*p*-Value
Looking at this donor made me feel uncomfortable	2.24 ±0.98	2.64 ±1.16	< 0.001*
Dissecting this donor made me feel uncomfortable	2.17 ±0.98	2.43 ±1.13	0.034*
This donor's appearance resembled the images shown in lecture	3.82 ±0.78	3.72 ±0.96	0.495
The odour of the chemicals secreted from the donor negatively impacted my dissection	2.86 ±1.11	2.84 ±0.98	0.845
Dissecting this donor helped in my learning of anatomy	4.50 ±0.54	4.46 ±0.62	0.597
This donor had a similar range of motion compared to the average individual	2.58 ±1.12	3.67 ±1.06	< 0.001*

*p-value is significant tested as a 95% confidence level

Table IV. Students' feedback in the open-ended section of the questionnaire.

Students' Comments
ICL-SP bodies were very inconsistent- some were great others were difficult. Traditional embalming was more constant.
Overall ICL-SP is more realistic and easier to see structures
ICL-SP was better overall. Learned much more
Overall, I preferred the ICL-SP bodies over the formalin bodies in every aspect outside of the musculature. Muscles on the ICL-SP bodies became very "squishy"
I feel that starting with the traditional body helped me adapt to the lab initially. If I were to begin with the ICL-SP- more lifelike, I would have had much harder time emotionally. Some of these differences were due to have a body with bigger muscles and structures than B
While mine did not, some ICL-SP bodies have overwhelmingly bad scent
ICL-SP body was easier to differentiate between structures, but was a bit sloppy and muscles would droop
Both similar, fresh ICL-SP colors more vibrant, easier to differ muscles and arteries

Participants with no prior experience with human donors were significantly more uncomfortable with the appearance of formaldehyde embalmed donors than participants with experience utilizing human donors, as both prosections and dissection models (statistic, *p*-value/ table). Additionally, evaluation of student perception of anatomical learning utilizing the formaldehyde embalmed donor showed significance (statistic, *p*-value/ table) which was due to participants with prior experience utilizing human donor prosections believing the dissection of formaldehyde donors as less helpful to anatomical learning than participants with experience utilizing human donors for dissection or no previous experience with human donors. The impact of participant's undergraduate major on the dissection experience showed no significant findings. The impact of the students' program of study on the dissection experience presented a significant difference in student comfort during dissection of formaldehyde embalmed donors (statistic, *p*-value= 0.003). This significance showed that the physical therapy students were more comfortable during the formaldehyde donor dissection than their occupational therapy student counterparts. The impact of student professional program also was assessed regarding all questions in the range of motion assessment questions, clinical skills questions, and anatomical knowledge questions and showed no significant findings.

Range of Motion and Preference. Students had an increased perception of successfully capturing the range of motion at both the ankle joint while undergoing plantar flexion and dorsiflexion ($p<0.0001$) and at the wrist joint while undergoing radial and ulnar deviation ($p<0.0001$) while utilizing the ICL-SP embalming methodology. Students reported that for both the wrist and ankle, ICL-SP was a better model for measuring range of motion ($p<0.0001$).

Comparison of which donor type better allowed participants to measure range of motion at the ankle or wrist was evaluated utilizing a paired t-test showing no difference in ability to measure range of motion based on joint location ($p<0.532$). Students also noted that ICL-SP donors were better for range of motion measurements at the wrist ($p<0.0001$) and ankle ($p<0.0001$) while increasing their confidence to perform the range of motion exams again ($p<0.0001$).

Clinical Testing and Preference. Students believed the integration of the Lachman's test into the anatomy laboratory allowed for the successful assessment of the anterior cruciate ligaments function ($p<0.0001$). Students also believed the integration of the Valgus Stress Test of the elbow allowed for successful assessment of the ulnar collateral ligaments function ($p=0.002$). Students believed that ICL-SP better assisted in the learning of the Lachman's test ($p<0.0001$) and the Valgus Stress Test of the elbow ($p<0.0001$).

Anatomical Impact

Participants believed that completing the clinical skills increased their understanding of the associated anatomy ($p<0.0001$). The integration of clinical skills significantly increased the motivation of participants to learn anatomy ($p<0.0001$) and gave the students a better understanding as to why knowledge of anatomical structures as it relates to their future professions ($p<0.0001$). Lastly, students enjoyed the integration ($p<0.0001$).

DISCUSSION

The aims of this study were to evaluate the impact of integrating clinical skills into anatomy curricula, while comparing ICL-SP preservation and traditional formaldehyde preservation. The utilization of ICL-SP donors showed perceived benefit in the identification of arteries and nerves of the donor while showing no deficit in identification of other structures when compared to the traditional formaldehyde embalmed donor. The integration of clinical skills into the anatomy curricula showed increases in perceived learning of associated anatomical structures along with increasing students' motivation to further their anatomical learning. The integration of clinical skills into the anatomy curriculum while utilizing the ICL-SP embalming technique shows that ICL-SP could serve as a better model for the learning of clinical skills compared to the traditionally used formaldehyde embalming technique.

Dissection Experience. When students were asked about their experience while undergoing dissection of formaldehyde and ICL-SP donors, many of the questions either favored that of the ICL-SP donors or showed no significant difference but did show that the ICL-SP donors served better for the systemic identification of vasculature and nerves. Students reported that the utilization of embalmed human tissues helped with their learning of anatomy which is consistent with previous research (McLachlan *et al*., 2004; Patel & Moxham, 2008; Ghosh, 2017; Balta *et al*., 2019) but there was no preference in the embalming type.

The utilization of ICL-SP was shown to cause increased feelings of discomfort. This could be due to the increased lifelike appearance of alcohol based embalming types (such as ICL-SP) when compared to formaldehyde (Richens *et al*., 1963; Balta *et al*., 2015, 2017, 2019; Kennel *et al*., 2018) or because 40 % of the sample had no previous experience with human donors and 30 % had only worked with prosections of human donors. Lastly, ICL-SP donors presented a remarkably similar range of motion compared to the living individual, which is significant due to the focus on motion within the physical and occupational therapy career. Students with prior exposure to both dissection and prosection were more comfortable with the appearance of formaldehyde donors than the students that had no previous exposure to human donors. This may be due to the concept of increased experience leading to increased comfort (Garavatti *et al*., 2018; Huo *et al*., 2020). This difference could be due to increased experience with donors, specifically formaldehyde embalmed donors leading to habituation of negative external stimuli surrounding the donors. This could lead to statistical differences, when comparing these students to novice students. Additionally, those with experience utilizing human donors only as prosections believed the dissection of formaldehyde donors was less beneficial to their anatomical learning. This could be due to a potential pre-existing bias that dissection may be inferior to prosections as a teaching method due to differences in dissection quality of student dissection and preserved prosections.Interestingly, first year physical therapy students were significantly more comfortable dissecting formaldehyde donors than their occupational therapy counterparts. Though there is a statistical difference

it is likely not due to the student's current program as students in this course are in their first semester of their respective professional school. The difference is likely due to a student difference not covered in the scope of this study.

Range of Motion and Clinical Skills. ICL-SP was perceived to be better when performing the range of motion measurements, likely due to the retention of joint flexibility associated with ICL-SP. This led to an increase in understanding of the associated musculature. The increase could be credited to the visualization of tendons, ligaments, and muscles during the locomotion of the distal limb as described by Dausseau in 2008. Additionally, the increase of anatomical understanding in conjunction with the newer simulation-based education could explain the increase in confidence of students performing the range of motion measurements in the future. The mental conceptualization of the measurements followed by the student undergoing the motor function portion of the measurement could lead to an increase in confidence of performing the action again in the future, potentially on a living individual which is consistent with the simulation-based education model proposed by Sawyer *et al.* (2015).

Students denoted that they were not only able to assess the function the anterior cruciate ligament of the knee during the Lachman's test and the ulnar collateral ligament of the elbow during the valgus stress test but that they preferred ICL-SP as a better model for the clinical skills. Students were better able to assess the function of the ACL and the UCL on ICL-SP donors than that on the formaldehyde donors. This could again be due to the retention of joint mobility causing retained elasticity of the associated ligaments and musculature when utilizing the ICL-SP method allowing for a more lifelike representation, like that of a living individual. This retained flexibility may also be credited for the students indicating that ICL-SP was more beneficial in their learning of performing the Lachman's test and valgus stress test of the elbow. The results of these questions focused on the use of the new embalming type with respects to range of motion and clinical tests shows ICL-SP has potential as the primary fixative method for donors that were utilized for musculoskeletal physical examinations.

Integration of Clinical Skills and Anatomy. The final portion of the questionnaire was aimed to evaluate the opinions of students with respect to the integration of clinical skills into the anatomic curriculum and perceived benefits independent of embalming type. Participants communicated that the completion of the Lachman's test, and the valgus stress test of the elbow increased the perception of the students learning associated ligament of interest (the anterior cruciate ligaments of the knee and the ulnar collateral ligament of the elbow). This could be showing that the integration of the clinical skills to complement learning of anatomical structures increases the total learning as described in previous research (Dasseau *et al*., 2008; Wilson *et al*., 2009; Krause *et al*., 2011). This can further be seen through student responses that indicate the integration helped them understand how anatomy is important to their careers. This study shows that the inclusion of clinical skills that were enjoyed by the students may have increased motivation for the students to learn anatomical knowledge.

Despite the thorough nature of this study's methodology, there are still limitations present. One of these limitations is the sample. With having a single sample within the same course undergoing dissection of both ICL-SP and formaldehyde donors at congruent times could cause students to develop bias. The students dissecting one embalming methodology may interact with the other embalming type and form preconceived notions prior to the desired time for students to dissect the opposite embalming type. Additionally, there was no way to limit the communication of participants during the dissections or during the performance of the clinical skills. Another limitation of this study is the utilization of perceived learning, instead of testing learned knowledge through examination.

CONCLUSIONS

This study supports the inclusion of clinical skills into anatomy education, by demonstrating an increase on perceived anatomical learning of structures associated with clinical skills, increased understanding of how anatomy is important to future profession, and increased motivation to learn anatomy that correlate to relevant coursework and clinical skills.

The use of ICL-SP donors was perceived to be comparable to formaldehyde donors in terms of most dissection criteria. Formaldehyde proved to be less beneficial for the identification of nervous and vasculature tissues. This indicates that ICL-SP has potential of becoming a primary embalming type in anatomical coursework that calls for systemic dissection, identification neurovascular structures, and the integration of clinical skills.

Through the results of this study, it can be inferred that the integration of clinical skills into the anatomy curricula and the utilization of ICL-SP as a primary embalming methodology can potentially increase the learning outcome within allied health education. The integration of these variables additionally shows increases

in perceived anatomical learning and better knowledge and confidence in performing clinical skills than clinical skills on formaldehyde or observing demonstrations.

Key findings:

- Using soft preservation techniques, such as ICL-SP, helps improve the dissection experience with identification of neurovascular structures.
- Using soft preservation techniques helps integrate clinical skills into the anatomy curriculum by better representing a living human response to range of motion and ligament clinical tests.
- Integration of clinical skills into anatomy curriculum, independent of embalming type helps to improve understanding and motivation to learn.

What the study has added: Integrating clinical skills into the anatomy learning experience is beneficial and even more realistic when using soft preserved body donors.

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RESUMEN: Las habilidades anatómicas y clínicas se enseñan por separado a los estudiantes de terapia física y ocupacional. El formaldehído es el químico principal que se usa para embalsamar a los donantes, lo que crea un desafío para integrar las habilidades clínicas en el plan de estudios de anatomía. Este estudio tuvo como objetivo evaluar la integración de habilidades clínicas en la educación anatómica utilizando Imperial College London-Soft Preservation (ICL-SP) y embalsamamiento de formaldehído a través de la evaluación del aprendizaje y la confianza percibidos por los estudiantes. Se invitó a los estudiantes a completar una encuesta después de diseccionar un ICL-SP y donantes embalsamados formolizados y realizar pruebas clínicas. Fue más fácil diseccionar e identificar estructuras neurovasculares en donantes ICL-SP en comparación con los fijados en formaldehído. Las pruebas clínicas, como la medición del rango de movimiento y las pruebas de ligamentos, también fueron más realistas en los donantes de ICL-SP. La integración de habilidades clínicas en el plan de estudios anatómico aumentó la comprensión percibida por los estudiantes de anatomía asociada ($p < 0,001$), dio una mejor comprensión de cómo la anatomía es importante para sus profesiones ($p < 0,001$) y aumentó la motivación para aprender anatomía ($p < 0,001$). La integración de las habilidades clínicas en la educación anatómica puede facilitar el aprendizaje de los estudiantes con mayor confianza en el desempeño de las habilidades clínicas y se complementa con la utilización de la nueva metodología ICL-SP en lugar de la conservación tradicional con formaldehído.

PALABRAS CLAVE: Anatomía; Terapia física; Terapia ocupacional; Educación; Preservación suave; Currículo Integrado.

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