Inv Ed Med. 2017;6(22):70–74

Investigación en Educación Médica

http://riem.facmed.unam.mx

ORIGINAL ARTICLE

Anatomical knowledge in veterinary medical students in Chile

Juan Claudio Gutierrez[a,*], **Marcelo Gomez Jaramillo**[b], **Gabriela Sudel**[b], **Mary Renee Prater**[c]

[a] *Department of Anatomy, Physiology and Cell Biology, School of Veterinary Medicine, University of California, Davis, USA*
[b] *Pharmacology and Morphophysiology Institute, School of Veterinary Sciences, University Austral of Chile, Valdivia, Chile*
[c] *Department of Biomedical Sciences, Edward Via College of Osteopathic Medicine, Blacksburg, USA*

Received 3 December 2015; accepted 25 April 2016
Available online 30 May 2016

KEYWORDS
Retention;
Veterinary anatomy;
Veterinary education

Abstract
Introduction: Anatomy is considered a cornerstone in human and veterinary medical education, as this basic science discipline provides a vital foundation on which to build the knowledge of the clinical practice of medicine.
Objective: The aims of this study were: 1) to collect information on first year veterinary student preference, and use of supportive educational tools, and 2) to assess long-term knowledge retention in senior veterinary students who successfully completed the bovine anatomy course.
Method: A survey was administered to first-year veterinary students in order to identify their learning tools of choice, and a diagnostic examination was designed to reflect highly relevant basic anatomy knowledge was administered to senior veterinary students.
Results: Besides the regular cadaver-dissection laboratories, textbooks were the tool used most frequently by first-year students to learn bovine anatomy. Computer technology was used by only 12.2% of the students. When evaluating knowledge retention of bovine anatomy by fourth year (senior) students, only 33.2% of the questions were answered correctly in the fourth year examination.
Conclusions: These results were interpreted as a low long-term retention of knowledge in Chilean veterinary medical students.

* Corresponding author.
E-mail address: jcgutierr@ucdavis.edu (J.C. Gutierrez).
Peer Review under the responsibility of Universidad Nacional Autónoma de México.

http://dx.doi.org/10.1016/j.riem.2016.04.004

PALABRAS CLAVE
Retención;
Anatomía veterinaria;
Educación veterinaria

Conocimiento de anatomía en estudiantes de medicina veterinaria en Chile

Resumen
Introducción: La anatomía es considerada una piedra angular en la educación médica humana y veterinaria, ya que esta disciplina científica básica proporciona una base fundamental sobre la que se construye el conocimiento de la práctica clínica médica.
Objetivos: Los objetivos de este estudio fueron: 1) recoger información en estudiantes de primer año de medicina veterinaria sobre el uso de herramientas educativas de apoyo en el aprendizaje de anatomía y 2) evaluar la retención de conocimientos de anatomía a largo plazo en los estudiantes de veterinaria de niveles superiores y que hayan completado con éxito el curso de anatomía del bovino.
Método: Para ello se aplicó una encuesta a estudiantes de primer año para identificar sus metodologías de aprendizaje, y adicionalmente un examen de diagnóstico que fue diseñado y aplicado a estudiantes de niveles superiores con el fin de reflejar el conocimiento de anatomía fundacional de relevancia.
Resultados: Los resultados indicaron que, además de los laboratorios regulares de disección, los libros de texto eran la herramienta más utilizada por los estudiantes de primer año para aprender anatomía del bovino. Las tecnologías informáticas fueron utilizadas por solo el 12.2% de los estudiantes. Las tecnologías informáticas fueron utilizadas por solo el 12.2% de los estudiantes.
Al evaluar la retención del conocimiento de la anatomía del bovino en estudiantes de cuarto año, solo el 33.2% de las preguntas fueron contestadas correctamente.
Conclusiones: Estos resultados fueron interpretados como una baja retención a largo plazo de los conocimientos de anatomía en estudiantes chilenos de medicina veterinaria.

Introduction

On a global scale, the higher education systems in medical and veterinary colleges are facing significant challenges in how to most efficiently impart large volumes of medical knowledge to their students in such a way that promotes long-term retention of the material, inter-disciplinary integration of the material, and effective clinical application of the material. These institutions are actively seeking to integrate conventional teaching practices such as lecture-based information transfer and required textbook reading, use of experiential learning tools such as cadaver labs and plastinated specimens, and application of novel technologies of information and communication (TIC) to optimally prepare students to serve the community in health care in the 21st century. Considering the rapid changes that are taking place in the use of information technology by our students, educational institutions are being challenged with the responsibility of assuming a role of leadership in the transformation of educational materials to maximize efficiency of learning and retention of medical knowledge for clinical application by our millennial students.[1]

Historically, anatomy has been considered to be a keystone discipline in the medical professions, as this basic science discipline offers vital foundational knowledge of how the structure of an organism relates to its function in health, and the appreciation of how the three-dimensional structure of the organism relates to physical and radiological diagnosis of disease, as well as surgical and medical approaches to treatment of the disease. Until recently, the combination of cadaveric dissection, required reading, and didactic lectures were the primary effective methods used for teaching anatomy.[2] Recently, as the availability of adequate specimens for dissection has become more limited or cost-prohibitive, and the time allotment for anatomy laboratories in the curriculum has become more restricted,[3] anatomy instructors have searched for novel methods to impart vital anatomical knowledge. Many anatomy programs rely only on use of anatomy books and atlases for student instruction, in the absence of cadaveric dissection, because of space, time, and financial constraints, and this is believed to be suboptimal for anatomy learning.[4] Other programs utilize preserved or plastinated anatomy specimens (cadaveric material processed to remove water and fat, and replace it with a permanent synthetic polymer) to improve the quality of their teaching.[5] However, use of plastinated sections reduces the opportunity for students to prosect and dissect cadaveric material, which limits the effectiveness of anatomy instruction as it relates to appreciation of the three-dimensional orientation of organs in a system. Additionally, compelling evidence suggests that these methods of instruction may be inadequate, and result in poor long-term retention of anatomical knowledge, which was the motivation for the present study.[6]

Many colleges and universities have endeavored to improve the process of learning anatomy for long-term retention and effective clinical application, by developing novel computer technology. In 1996, instructors affiliated with the Austral University of Chile developed a photographic software of Bovine Osteology, and although this

material was produced to facilitate students' learning, the software was infrequently used because of insufficient student access to institutional or personal computers. Today, this software is obsolete because original versions of the software are incompatible with the current computer operating systems, and updates were not generated to keep up with the evolution of computer hardware. More recently, the University of Georgia developed a software program called ''The Glass Horse''.[7] This software allows virtual visualizing the equine digestive tract in a three-dimensional, interactive manner. This software has been positively received by students and has facilitated learning of a complicated gastrointestinal organ system, and although it is limited by single species and organ system, it is a step in the right direction. In 2003, the Universidad de Murcia in Spain developed interactive software of the musculoskeletal system of the dog, based on photographs of dissections. These software programs represent some of the efforts being made by veterinary anatomists to improve the quality of the instruction, although they are limited to a single region or organ system and a specific animal species. Recently, many human dissection software packages have become available, which have greatly improved clinical application and long-term learning of anatomy by medical students: several of these packages include The Visible Body (Argosy Publishing Co), 3D Virtual Anatomy Studio (Cloudstars Software), The Biodigital Human (developed by the NY School of Medicine), VH Dissector (ToLTech) and many others. Clearly, the veterinary educational community could benefit greatly from similar interactive computer programs tailored to small and large animal anatomy.

Based on the knowledge that many veterinary programs are limited in their instructional tools with which to teach anatomy due to limitations in cadaver lab dissection, and limited availability to virtual dissection programs, the anatomy instruction of veterinary medical students using primarily textbooks as a teaching tool provide inadequate opportunities for long-term learning and appropriate clinical application for the material. For the same reason, new virtual software programs and novel approaches in teaching are needed to help veterinary students more effectively to retain their anatomical knowledge.

Method

The following study was conducted to obtain an overview of study methods and knowledge retention of veterinary students in the College of Veterinary Sciences of the Austral University of Chile, in order to identify a need for novel interactive computer instructional tools, and inform future development of such tools or methodologies to enhance student learning and retention in the field of anatomy. The course selected to conduct these studies was ''Bovine Anatomy'', a mandatory course of the first year of the veterinary medical curriculum.

The pedagogic methodology for instructing Veterinary Anatomy has not changed substantially in the last 15 years at the College of Veterinary Sciences at the Austral University of Chile. This methodology includes lectures and guided cadaver based dissection labs. For the same reason, the present study was performed to assess two critical aspects of Veterinary Anatomy instruction:

1) Evaluation of the tools first year DVM students used when studying Bovine Anatomy via class survey, and
2) Evaluation of the knowledge retention via written examination on the subject of Bovine Anatomy by senior DVM students who studied the subject in their first year. The DVM curriculum is five years long in the School of Veterinary Medicine at Austral University.

The present study followed all the research ethical requirements and policies established by the Austral University of Chile.

Survey

Ninety-two 1st-year students (out of 104) enrolled in the Bovine Anatomy course responded to a survey after successful completion of the course. These students had access to lectures, textbooks, and limited access to cadaver-based dissection labs during this course. Questions on the survey included a list of tools the students used to support the study of anatomy, like books and software programs, and consultation with an instructor. It was also inquired if the student had a special interest within anatomy they considered of clinical relevance in the future clinical and surgical curriculum. Answering this question could indirectly assess the student level of appreciation of future clinical applications of the knowledge gained in the Bovine Anatomy course.

Diagnostic test

A diagnostic exam was given to 29 senior students. The exam included general questions on Musculoskeletal, Nervous, Gastrointestinal and Cardiovascular Systems. The type of questions on the exam were: multiple choice (12 questions), True or False (12 questions) and short answer (3 questions). The exam followed a traditional structure that matched the learning outcomes for the bovine anatomy class.

Statistical analysis

The results of the survey and diagnostic exam were analyzed by means of descriptive statistics. Frequencies were established for the obtained information to be expressed as percentages.

Results

Survey

From the analysis of the survey, we concluded that anatomy books (38.5%) and notes from lectures (29.1%) are the main resources used by the freshmen students to supplement knowledge gained in cadaveric dissection labs.

Among the consulted anatomy books, the Atlas of Topographic Anatomy of the Domestic Animals by Popesko, and Bovine Anatomy by Butendieck (Volumes I and II, notes for bovine anatomy) were the most frequently used. Bovine Anatomy by Butendieck is the required textbook for the

Bovine Anatomy course at Austral University.[8,9] However, Popesko's atlas contains numerous full-color images that likely fill an important niche in the study of Veterinary Anatomy.[10]

Among the 22 students consulting computer software technology, the majority (90.9%) used the Atlas of Veterinary Osteology of the Veterinary College of the University of Temuco (Chile), whereas 9.1% used a web site in a Flash platform of the Institute of Veterinary Anatomy of the University of Concepcion (Chile). These 2 sources offer osteology content that includes the bovine species. The platform from the University of Concepcion additionally offers general aspects of comparative anatomy of the gastrointestinal and cardiovascular systems including the bovine species.

Because there are few interactive virtual dissection programs available, students were creative in maximizing their mastery of the material; some students photographed dissected specimens and labeled them for their study; others returned to the anatomy laboratory after hours for additional study time; still others watched video recordings of instructor-narrated cadaveric dissection to supplement their anatomy study. However, based on the results that 97.8% of polled students felt enthusiastic about the availability of multimedia software as an improved virtual dissection tool indicated significant inadequacy of the presently available learning tools and a great opportunity for veterinary anatomic dissection software development.

Finally, in relation to special anatomy interest of the students, 80 responses were obtained. Cardiovascular system (22.5%) and musculoskeletal system (18.8%) where considered as topics of major interest by the students. These results indicated that students do not have a full appreciation of the clinical applications of anatomy with respect to understanding of the relationship between form and function in health, nor an understanding of the need for health providers to have a strong comprehension of anatomic structures for effective diagnosis and treatment of disease.

Diagnostic test

The 29 fourth year student exams were graded and responses were analyzed. Of the 709 responses generated from the exam, only 33.2% of the questions were answered correctly, and 66.8% of the answers were either unanswered or answered incorrectly. As the exam was designed to examine a basic level anatomic competency that would be required for effective clinical practice, the low percentage of correctly answered questions strongly suggested inadequate retention of knowledge through the veterinary curriculum, which further supports the idea that novel teaching materials are necessary to improve the learning process in the field of anatomy.

Discussion

The 1st-year veterinary student survey, in combination with the last year exam, collectively demonstrate that the use of anatomy textbooks as the main source of support used by the students is inadequate for long-term retention of anatomic medical knowledge. The low percentage of students using available computer software technology as method of study can be explained by the fact that these are not readily available for the bovine species, and those that are available are limited to a specific organ system in a specific species, that is not easily translatable to other companion or production animal species. However, there was a high percentage of students who would like to have this technology available, which presents a great opportunity for three dimensional, interactive virtual dissection software development in the veterinary field.

It was interesting that only 15% of the students used ''The Guide to Dissection of the Bovine'', a book that is required in the curriculum.[11] It is likely that this book was not preferred by the majority of the class because it contains very few images, which likely did not satisfy the needs of the students in a very visual discipline. As such, updated versions of this book, or interactive computer software technology to include more images would greatly improve the effectiveness of student learning and retention of material in this discipline.

Because relatively few students were able to identify a specific organ system that should receive high priority in the instruction of anatomy, it is possible to infer that a scarcity of knowledge exists on the clinical implications of the Bovine Anatomy class. For example, only 5% of the students considered that would be useful to emphasize the reproductive system, which is a key organ system in bovine clinical and management work in the field. Therefore, clinical applications of anatomy, to show relevancy of anatomical knowledge in radiologic and palpation diagnosis of disease, and surgical and medical approaches to treatment of disease, would be vital components to consider during development of new instructional tools such as interactive computer software.[3]

Twenty nine senior students out of a total of 65 answered the exam. For the short answer questions, incomplete responses were considered incorrect. Considering the complete pool of questions, 27.5% were not answered, 33.2% were answered correctly and 39.3% were answered incorrectly. Sotomayor conducted a similar study in 1995,[12] to evaluate knowledge retention in Bovine Anatomy in a group of senior students at the University Austral of Chile. The results of this report were more encouraging than the obtained in the present work, with 54% of correct responses obtained. Unfortunately, the aforementioned report did not include a copy of the exam, and as a result, it is not possible to compare the complexity between both exams. However, despite numeric differences in the student performance on these two exams, collectively they demonstrate a consistent lack of long-term retention of vital anatomical medical knowledge, and together emphasize the great need for novel instructional tools and technologies to promote more efficient learning and retention of the discipline of anatomy in veterinary students.

Lately, use of computer software technology for the education of anatomy has increased tremendously, with some colleges of human medicine using this technology as the primary means for anatomy instruction.[13] As the quality and availability of computer software technology increases, it is expected that students will be able to use this novel tool as an adjunct to didactic instruction and hands-on laboratory experiences, to more effectively learn the discipline of anatomy, and to retain this information long-term,

for clinical application. The veterinary community is in critical need of new three-dimensional virtual dissection computer software programs, similar to the ones that are available in the human anatomic field, to aid in this process.

As a major conclusion, the results of this pilot study suggest that veterinary bovine anatomy instruction using primarily textbooks as a teaching tool provide inadequate opportunities for long-term learning and appropriate clinical application for the material. Further and more expansive studies involving large number of veterinary senior students and a broader scope of inquiry is now necessary, and longitudinal study of individual classes of students will minimize inter-class variability, to better understand the needs of veterinary students, to maximize their learning and clinical application of the discipline of anatomy across species.

Ethical responsibilities

Protection of people and animals. The authors state that for this investigation have not been performed experiments on humans or animals.

Confidentiality of data. The authors declare that this article does not appear patient data.

Right to privacy and informed consent. The authors declare that this article does not appear patient data.

Authorship/contributors

JCG and GS designed and coordinated the research and the implementation and evaluation of assessment tools, document drafting, discussion and conclusions. MG and RP conducted the review of written, statistical, methodological analysis and analysis of results.

Conflict of interest

The authors have no conflicts of interest to declare.

Acknowledgment

None.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.riem.2016.04.004.

References

1. UNESCO. Guía de planificación: Las tecnologías de la información y comunicación en la formación docente: Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura; 2004.
2. Sugand K, Abrahams P, Khurana A. The anatomy of anatomy: a review for its modernization. Anat Sci Educ. 2010;3:83–93.
3. Inzunza O, Bravo H. Animación computacional de fotografías, un real aporte al aprendizaje práctico de Anatomía Humana. Int J Morphol. 2002;20:151–7.
4. O'Byrne PJ, Patry A, Carnegie JA. The development of interactive online learning tools for the study of anatomy. Med Teach. 2008;30:e260–71.
5. von Hagens G, Tiedemann K, Kriz W. The current potencial of plastination. Anat Embryol. 1987;175:411–21.
6. Jiménez R, Isaza O. Plastinación, una técnica moderna al servicio de la anatomía. IATREIA. 2005;18:99–106.
7. Scherzer J, Buchanan MF, Moore JN, White SL. Teaching veterinary obstetrics using three-dimensional animation technology. J Vet Med Educ. 2010;37:299–303.
8. Butendieck E. Anatomia del Bovino. Tomo I. Valdivia. Chile Facultad de Ciencias Veterinarias, Universidad Austral de Chile; 2009.
9. Butendieck E. Anatomia del Bovino. Tomo II. Valdivia. Chile Facultad de Ciencias Veterinarias, Universidad Austral de Chile; 2009.
10. Popesko P. Atlas of topographical anatomy of the domestic animals. 2nd ed. Philadelphia: W B Saunders Co; 1978.
11. Butendieck E. Guia de diseccion del bovino. Valdivia, Chile: Facultad de Ciencias Veterinarias, Universidad Austral de Chile; 2009.
12. Sotomayor LM. Persistencia de los conocimientos de la asignatura de Anatomía del Bovino en los estudiantes de Medicina Veterinaria de la Universidad Austral de Chile. Memoria de Título. Valdivia, Chile: Escuela de Medicina Veterinaria, Universidad Austral de Chile; 1995.
13. Insunza O, Bravo H. Impacto de dos programas computacionales de anatomía humana en el rendimiento del conocimiento práctico de los alumnos. Int J Morphol. 1999;17:205–9.