ORIGINAL ARTICLE

Emphasis on various subtopics in the anatomy curriculum for chiropractic training:
An international survey of chiropractors and anatomists

Peter D. Chapman, MChiro, Amanda Meyer, PhD, Kenneth Young, DC, MAppSc, Daniel Wibowo, MD, and Bruce Walker, DrPH

Objective: The aim of this study was to conduct an international survey of the perceived optimal level of anatomy teaching from anatomy academics and practicing chiropractors. We hypothesized that the optimum level of anatomical understanding for chiropractic students does not differ between the anatomists teaching the students and practicing chiropractors.

Methods: The opinion of anatomists teaching in a chiropractic course ($n = 16$) was compared to practicing chiropractors ($n = 589$). The students' level of understanding was based on the revised Bloom's taxonomy for 16 different curriculum areas. Anatomists were recruited by contacting the accredited chiropractic courses worldwide. Snowball sampling was used for the practicing chiropractors. Independent-samples Mann-Whitney U tests were used to compare the results of anatomists and chiropractors.

Results: Opinions differed between anatomists and chiropractors on 9 out of the 16 questions. Where opinions differed, chiropractors recommended a higher standard of anatomical knowledge. The level suggested by chiropractors for these curriculum areas is equal to the "evaluating" level where chiropractic students can remember, understand, apply, and analyze anatomical knowledge to be able to justify a clinical decision.

Conclusion: Compared to anatomists working in chiropractic programs, chiropractors suggest a higher standard of anatomy be taught to undergraduates. Collaboration between chiropractors and anatomists would likely be beneficial in creating or modifying anatomy curricula for chiropractic students.

Key Indexing Terms: Anatomy; Chiropractic; Curriculum; Education

INTRODUCTION

A sufficient knowledge or mastery of human anatomy is required by those working in the health professions. The level of knowledge differs among the different professions, with some requiring an in-depth knowledge of specific parts of the body rather than general anatomical knowledge. For example, dental students require emphasis on the oral cavity and podiatrists on the feet. For chiropractors, there is little research on the depth and breadth of research required for safe and effective practice. In Australia this situation is not unique to chiropractic; studies at medical schools have found that there is no consensus on exactly what students need to know.[1] Excerpts from accreditation requirements of several chiropractic bodies are shown in the Appendix (available online as supplemental material at www.journalchiroed.com).

The Council on Chiropractic Education Australasia[2] has broad accreditation standards for teaching basic sciences, including anatomy. The documentation outlines that chiropractic student basic science should cover "a core of information on the fundamental structures, functions and interrelationships of the body systems."[2] The vagueness of this statement and the lack of a national standardized anatomy curriculum in chiropractic education make teaching anatomy to chiropractic students quite challenging. A review of a convenience sample of the websites of 6 chiropractic schools indicates that the teaching of anatomy differs. We selected these programs because their anatomy syllabi were available online. The reasons for the differences observed are not clear. In addition, it is not clear if the syllabi surpass or meet the level required by the various accreditation authorities. Thus, what is the optimum level of anatomy to be taught? This study attempts to address this question.

From a pedagogical perspective, a synergy exists between the retention of anatomical knowledge and

1. Morphology (structure) of human bone and joints
2. Function of human bone and joints
3. Morphology (structure) and topography (relationships between various structures) of skeletal muscles
4. Function of human muscles
5. Morphology (structure) of joints
6. Function of joints
7. Relationship of the morphology (structure) of bone, joint and muscles with their basic function
8. Morphology (structure) of the human nervous system
9. Function of the human nervous system
10. Morphology (structure) and topography (relationships between various structures) of organs and other human structures
11. Functions of organs and other human structures
12. Physical variations of the human body
13. Relationship of the morphology (structure) of organs and tissues with their basic function
14. Morphology (structure) and topography (relationships between various structures) of organs and other human structures for rehabilitation and other supportive measures
15. Function of organs and other human structures for rehabilitation and other supportive measures
16. Principles regarding how to respect and work with human cadavers

Figure 1 - Curriculum areas for survey questions.

clinical application in chiropractic students.[3] The ability to differentially diagnose patients requires that chiropractic students have sufficient anatomical knowledge. The majority of patients seeking chiropractic care are affected by back and neck problems.[4] However, some serious and life-threatening medical conditions, such as a dissecting aortic aneurysm, ectopic pregnancy, or myocardial infarction, can in fact present as acute back pain.[5] As point-of-entry health care professionals, chiropractors must have enough anatomical knowledge and the ability to apply it clinically to diagnose a patient in order to decide if the patient should be referred to another medical professional. It is therefore necessary to design a suitable course of anatomy that provides fundamental knowledge that enables the chiropractor to be able to diagnose or treat a patient within his or her special interest area.

Although there are individual variations between the anatomy courses of chiropractic institutions, it has been noted by other authors that all programs have similar gross anatomy course designs, delivery, and assessment methods.[6]

The aim of this study was to conduct an international survey of the opinions of anatomy academics at accredited chiropractic programs and chiropractors in practice regarding the optimum level of anatomy teaching. We hypothesized that the optimum level of anatomical understanding for chiropractic students does not differ between the anatomists teaching the students and practicing chiropractors.

METHODS

Participants

We attempted to contact all 27 anatomists at accredited chiropractic programs worldwide during the year 2010. Their details were obtained from institutional websites in the public domain. In 2011 chiropractors were contacted and recruited by using "snowball sampling" via chiropractic blogs and key informants. Snowball sampling uses a small number of initial participants who then recruit more participants through social networks. We contacted chiropractors who had blogs and other websites and asked them to provide some information about the survey and link to the survey on their blogs. The number of years practicing chiropractic and the country of origin were recorded.

Instrument of Measurement

Participants were asked to complete a survey that asked their opinion of the optimum level of anatomy that ought to be taught to chiropractic students in 16 curriculum areas. The instrument of measurement was a survey asking participants to indicate their opinion of the level of understanding that particular areas of anatomy should be taught to chiropractic students (Fig. 1). The level of understanding was based on the revised Bloom's taxonomy, as shown in Table 1. Bloom's revised taxonomy is a system used to qualitatively express different levels of understanding. Originally presented by Benjamin Bloom in the 1950s, the taxonomy was revisited in the 1990s by a

Table 1 - Revised Bloom's Taxonomy

Bloom's Taxonomy Level	Name	Description
6	Creating	Can the student create new a product or point of view?
5	Evaluating	Can the student justify a stand or decision?
4	Analyzing	Can the student distinguish between the different parts?
3	Applying	Can the student use the information in a new way?
2	Understanding	Can the student explain ideas or concepts?
1	Remembering	Can the student recall or remember the information?

committee formed by Krathwohl and Anderson, and a number of changes were implemented.[7] The predominant change was grammatical, interchanging nouns with verbs. The two highest orders of thinking were also interchanged to promote "creating" (originally "synthesis") to the highest level and to demote "evaluating" to the second highest level of thinking and evaluation. We did not use the highest level of thinking as described by the revised Bloom's taxonomy as we did not deem this level to be an appropriate (or required) level of thinking for chiropractic students in anatomy.

The survey asked participants to indicate the following: (1) if the level of knowledge should only enable students to recall information; (2) if students should be required to understand the knowledge; (3) if students should be able to apply the knowledge; (4) if students should be able to analyze their knowledge; and (5) if students should achieve a mastery level that enables them to evaluate the appropriateness of the knowledge in their circumstances. Each level bears an ascending value equal to that level of knowledge.

Human Subjects Considerations

Consent was implied by the completion and submission of the survey. The responses were anonymous, and the study was approved by the Murdoch University Human Ethics Committee.

Statistics

Responses were entered into SPSS version 21 (IBM Corp, Armonk, NY), and descriptive statistics were generated. Inferential statistics comparing the results of anatomists and chiropractors were also generated using independent-samples Mann-Whitney U tests.

RESULTS

Sixteen anatomists (response rate = 59%) and 589 chiropractors completed the survey. The use of snowball sampling precluded the ability to determine a response rate for chiropractors. Chiropractors had practiced for up to 54 years, with a median time of 11 ± 10 years (standard deviation; $n = 563$, data missing for 26 participants). Accordingly, we divided years of experience into two groups: (1) those with up to 11 years of experience and (2) those with more than 11 years of experience. We used a χ^2 test to determine whether years of experience was associated with taxonomy level and found no association between these variables (Table 2).

Table 2 - Practicing Chiropractors' Opinions of Level of Understanding of Anatomy According to Years of Experience

Curriculum Areas	Median Bloom's Taxonomy Level for Chiropractors With 0–11 yr Clinical Experience	Median Bloom's Taxonomy Level for Chiropractors With >11 yr Clinical Experience	χ^2	p Value
Morphology of bones and joints	4	5	8.76	.07
Function of nervous system	5	5	6.89	.14
Function of organs for rehabilitation	4	4	6.44	.17
Morphology of skeletal muscles	5	5	7.41	.18
Work with human cadavers	4	4	6.11	.19
Morphology of joints	5	5	5.57	.23
Function of joints	5	5	5.57	.23
Variations	4	4	4.94	.24
Relationship of organs and tissues	4	4	4.52	.34
Morphology of nervous system	5	5	4.35	.36
Morphology rehabilitation	4	4	3.91	.42
Function of muscles	5	5	3.69	.45
Relationship of bone, joint, muscle	5	5	3.15	.53
Function of organs	4	4	2.3	.68
Function of bones and joints	5	5	1.52	.82
Morphology of organs	5	5	1.15	.88

Bloom's taxonomy levels: 1 = remembering; 2 = understanding; 3 = applying; 4 = analyzing; 5 = evaluating; 6 = creating.

Table 3 - Practicing Chiropractors' Opinions of Level of Understanding of Anatomy According to Country of Origin

Curriculum Areas	Taxonomy Level United Kingdom and Ireland	Taxonomy Level Australia and New Zealand	Taxonomy Level United States and Canada	Taxonomy Level Europe	χ^2	p Value
Function of organs for rehabilitation	4	4	4	4	23.52	.1
Morphology of organs	5	5	5	4	21.94	.15
Function of bone and joints	5	5	5	5	21.18	.17
Work with human cadavers	4	4	4	4	20.13	.22
Morphology of skeletal muscles	5	5	5	5	17.13	.38
Relationship of bone, joint, muscle	5	5	5	5	16.85	.4
Variations	4	4	4	4	16.1	.45
Function of nervous system	5	5	5	4.5	14.94	.53
Function of organs	4	4	4	4	14.67	.55
Function of muscles	5	5	5	5	14.08	.59
Morphology of bones and joints	5	5	5	4.5	13.4	.64
Relationship of organs and tissues	4	4	4	4	12.82	.69
Morphology rehabilitation	4	4	4	3.5	9.93	.87
Morphology of joints	5	5	5	4	7.33	.97
Function of joints	5	5	5	4	7.33	.97
Morphology of nervous system	5	5	5	5	7.2	.97

Bloom's taxonomy levels: 1 = remembering; 2 = understanding; 3 = applying; 4 = analyzing; 5 = evaluating; 6 = creating.

Countries of origin for the practicing chiropractors were collapsed into 5 categories: Australia and New Zealand ($n = 162$), United States and Canada ($n = 114$), United Kingdom and Ireland ($n = 224$), Europe ($n = 54$), and other ($n = 9$); 26 were missing. The category "other" was then omitted because of the low number. We used a χ^2 test to determine whether country of origin was associated with taxonomy level and found no association between these variables (Table 3).

A comparison of the opinions of anatomists and chiropractors regarding students' optimum level of understanding of anatomy is shown in Table 4. Opinions differed between anatomists and chiropractors on 9 questions, but were the same for 7 questions. Where opinions differed, chiropractors recommended a higher standard of anatomical knowledge. It was their opinion that chiropractic students should attain a very high level of anatomical understanding regarding the morphology of organs, skeletal muscles, and the nervous system, as well as the functions of muscles, bones, and joints. The level suggested by chiropractors for these curriculum areas is equal to the "evaluating" level at which chiropractic students can remember, understand, apply, and analyze anatomical knowledge to be able to justify a clinical decision.

Table 4 - Comparison of Opinions of Anatomists and Chiropractors on the Optimum Level of Anatomical Knowledge in Relation to Bloom's Taxonomy Levels in Specific Curriculum Areas for Chiropractic Students[a]

Question	Chiropractor, $n = 563$	Anatomist, $n = 16$	Significance, p Value
Morphology of organs	5 (3.0, 5.0)	3 (1.4, 4.3)	.00
Morphology of nervous system	5 (3.0, 5.0)	4 (2.7, 5.0)	.00
Function of organs for rehabilitation	4 (2.0, 5.0)	3 (2.0, 5.0)	.00
Function of bone and joints	5 (3.0, 5.0)	4 (2.7, 5.0)	.00
Variations	4 (2.0, 5.0)	3 (2.0, 4.3)	.01
Morphology of skeletal muscles	5 (3.0, 5.0)	4 (2.7, 5.0)	.01
Function of muscles	5 (3.0, 5.0)	4 (2.7, 5.0)	.02
Function of organs	4 (2.0, 5.0)	3 (2.0, 5.0)	.04
Work with human cadavers	4 (3.0, 5.0)	3 (2.0, 5.0)	.05
Relationship of organs	4 (2.0, 5.0)	4 (2.0, 4.3)	.21
Relationship of bone, joint, muscles	5 (3.0, 5.0)	5 (2.7, 5.0)	.22
Morphology of bone and joints	5 (2.0, 5.0)	3 (2.7, 5.0)	.23
Morphology of joints	5 (2.0, 5.0)	4 (2.0, 5.0)	.42
Function of nervous system	2 (2.0, 5.0)	3 (3.0, 5.0)	.77
Morphology rehabilitation	4 (2.0, 5.0)	4 (2.0, 5.3)	.88
Function of joints	5 (2.0, 5.0)	4 (2.8, 5.0)	.90

Bloom's taxonomy levels: 1 = remembering; 2 = understanding; 3 = applying; 4 = analyzing; 5 = evaluating; 6 = creating.
[a] Data shown are median values (10th percentile, 90th percentile).

DISCUSSION

Anatomy is highly relevant to the clinical competencies that must be achieved by entry-level chiropractors, occupational therapists, and medical doctors.[2,8–10] To our knowledge, despite its importance, there are no national guidelines regarding a core anatomy curriculum or appropriate minimum content for anatomy curricula for chiropractic or medical programs in Australia or other countries.[8,11] Therefore, the development of anatomy curricula is the responsibility of individual institutions, which may vary in pedagogical approach, time allocated to anatomy, resources available, and staff qualifications.[6] The overall time allocated to teaching gross anatomy in the chiropractic program at Murdoch University is in excess of the average time of 19 medical schools across Australia and New Zealand.[3] Ideally, anatomists and clinical experts will collaborate in the future to develop national guidelines for anatomy programs.

The present study sought the opinions of anatomists and chiropractors on an anatomy curriculum as a preliminary step to the collaboration and development of national guidelines. Chiropractors, more often than anatomists, believe that chiropractic students should be taught and guided to achieve a higher level of understanding in over half the curriculum areas surveyed in the study. This is similar to the findings of Prince et al,[1] who found that anatomists set a lower standard than medical clinicians or year 4 students in the Netherlands. Ahmed and colleagues[12] also found disagreement among groups of respondents. Opinions of anatomists and chiropractors were most different regarding the optimum level of understanding in relation to the morphology of organs. We speculate this finding highlights that perhaps anatomists are currently not working closely enough with practicing chiropractors to guide the development of an anatomy curriculum that would best prepare a chiropractic student for the workforce. Anatomy is usually taught in the early part of the chiropractic program, and therefore anatomy would typically be taught in the preclinical training. This could influence how it is taught, as clinical care is relatively far off in the future, whereas chiropractors in the field are using their anatomy knowledge in a clinical setting. This could explain why they indicated that anatomy should be taught at a higher level of understanding than did the anatomists.

Anatomy is a basic science common to all health professions, and the anatomy curriculum for each health profession must be tailored to suit the needs of its graduates. The depth to which anatomy is taught may be a compromise between those advocating a strong foundation in the basic sciences and those that focus on clinical application.[13] Anatomists teaching chiropractic students may not have a chiropractic degree. A recent international survey of gross anatomy courses in chiropractic colleges found that 25% of the gross anatomy faculty did not hold a degree in chiropractic.[6] Unless these anatomists are guided by chiropractors and/or an accreditation body, the anatomy curriculum they develop may be suboptimal for the needs of chiropractic graduates. Serious and life-threatening medical conditions of the organs such as aortic aneurysm, ectopic pregnancy, myocardial infarction, and pancreatic or renal carcinoma can present as acute back pain.[5,14] Therefore, chiropractic students must have a good understanding of organ morphology and topography and be able to evaluate them in order to be able to differentially diagnose between musculoskeletal conditions and organ dysfunction that mimics musculoskeletal conditions.

The strength of this study was obtaining a large number of chiropractic respondents. However, this study had some limitations, including the potential for skewed data due to the low numbers of anatomists who responded. The response rate of chiropractors was not derived because the denominator was unknown owing to sampling technique. The Mann-Whitney U test is valid and robust with unequal sample sizes; however, as the inequality worsens, the chance of a statistically significant result diminishes. The number of years teaching anatomy was not recorded, and no open-ended questions were included to expand on why individuals held those opinions. It may be that an inexperienced anatomist, or an anatomist unfamiliar with chiropractic techniques, may not understand chiropractic requirements.

CONCLUSION

Compared to anatomists working in chiropractic programs, chiropractors suggest that a higher standard of anatomy be taught to undergraduates. Collaboration between chiropractors and anatomists would likely be beneficial in creating or modifying anatomy curricula for chiropractic students.

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About the Authors

Peter Chapman is a lecturer in clinical chiropractic at the School of Health Professions, Murdoch University (Room ECL 2.061, South Street, Murdoch Western Australia, 6150; p.chapman@murdoch.edu.au). Amanda Meyer is a lecturer at the School of Health Professions, Murdoch University (Room ECL 2.056, South Street, Murdoch Western Australia, 6150; a.meyer@murdoch.edu.au). Kenneth Young is a senior lecturer in chiropractic at the School of Health Professions, Murdoch University (Room ECL 2.066, South Street, Murdoch Western Australia, 6150; k.young@murdoch.edu.au). Daniel Wibowo is formerly a senior lecturer at the School of Health Professions, Murdoch University (Room ECL 2.061, South Street, Murdoch Western Australia, 6150; dswemc@yahoo.com). Bruce Walker is an associate professor at the School of Health Professions, Murdoch University (Room BITL 1.011, South Street, Murdoch Western Australia, 6150; b.walker@murdoch.edu.au). Address correspondence to Peter Chapman, Murdoch University, Room ECL 2.061, South Street, Murdoch Western Australia, 6150; p.chapman@murdoch.

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