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Radiological anatomy of the chest: what the general practitioner needs to know

Anatomia radiológica do tórax: o que o médico generalista precisa saber

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ABSTRACT

Introduction: In medical graduation, the methodology traditionally used in anatomy is cadaver dissection, methodology with several ethical and financial limitations. In this context, the use of imaging exams not only contributes to teaching human anatomy, fundamental knowledge for professionals, but also facilitates the understanding of radiology.

Objective: To develop a proposal on the radiological anatomy of the thorax, to establish which are the fundamental structures to be identified by general practitioners, and that serves the teaching of anatomy in undergraduate medicine.

Method: A questionnaire was sent to medical professors and/or preceptors of a medical course, in which they were asked to evaluate the relevance of thoracic anatomical structures in the context of radiology, based on the Likert scale. The form was structured into 4 sections based on the most used imaging exams. The responses were entered into an Excel® spreadsheet and statistically analyzed in relation to the degree of consensus. Structures considered recommended with a high and medium degree of consensus among experts were included in the Core curriculum.

Result: 26 medical professors and preceptors from 15 different medical specialties participated in the research. At the end, the proposed core curriculum consisted of 43 of the 94 structures initially listed.

Conclusion: It was possible and viable to develop a Core curriculum for radiological anatomy of the thorax, composed of 43 relevant structures to assist professionals in the evaluation of radiographic and computed tomographic examinations.

KEYWORDS: Medical education. Anatomy. Radiology.

RESUMO

Introdução: Na graduação médica, a metodologia tradicionalmente utilizada na anatomia é dissecção de cadáveres, metodologia com diversas limitações éticas e financeiras. Nesse contexto, o uso de exames de imagem não só contribui para o ensino da anatomia humana, conhecimento fundamental para o profissional, como facilita o entendimento da radiologia.

Objetivo: Elaborar proposta na anatomia radiológica do tórax, para estabelecer quais são as estruturas fundamentais a serem identificadas por médicos generalistas, e que atenda ao ensino da anatomia na graduação em medicina.

Método: Foi enviado questionário a médicos professores e/ou preceptores de um curso de medicina, em que eles deveriam avaliar a relevância de estruturas anatômicas torácicas no contexto da radiologia, baseado na escala de Likert. O formulário foi estruturado em 4 seções a partir dos exames de imagem mais utilizados. As respostas foram inseridas em planilha Excel® e analisados estatisticamente em relação ao grau de consenso. Foram incluídas no Core Curriculum as estruturas consideradas recomendadas com alto e médio grau de consenso entre os especialistas.

Resultado: Participaram da pesquisa 26 médicos professores e preceptores de 15 especialidades médicas distintas. Ao término, o core curriculum proposto era composto por 43 das 94 estruturas inicialmente listadas.

Conclusão: Foi possível e viável a elaboração de um Core curriculum de anatomia radiológica do tórax, composto por 43 estruturas relevantes para auxiliar os profissionais na avaliação de exames radiográficos e tomográficos computadorizados.

PALAVRAS-CHAVE: Educação médica. Anatomia. Radiologia.

Central Message

The methodology traditionally used in anatomy is cadaver dissection, which has several ethical and financial limitations. In this context, the use of imaging exams not only contributes to the teaching of human anatomy, fundamental knowledge for the professional, but also facilitates the understanding of radiology. Thus, this study elaborated a proposal on the radiological anatomy of the thorax, to establish which are the fundamental structures to be identified by general practitioners, and that meets the teaching of anatomy in undergraduate and medical practice.

Perspective

The use of technology represents a way to minimize the difficulties for teaching anatomy. The application of tools based on artificial intelligence, such as three-dimensional models of anatomical structures, performing imaging exams, enriches teaching, as they provide more dynamic and interactive learning, allowing students and physicians to better understand the concepts of clinical reality. Radiology, as a teaching tool, allows students to understand the anatomical position of the organs and structures of the human body in the context of diagnostic imaging. This study suggests key points that can be seen and analyzed to improve medical care.

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INTRODUCTION

Anatomy is the science that studies and analyzes the structure of the human body, its organs and systems. The term, of Greek origin, means "to dissect" or "cut into parts". Its understanding made it possible to understand human physiology and boosted the advancement of medicine, whose safe and effective practice requires mastery of anatomical knowledge by the professional.[1,2]

In undergraduate medicine, the study of human anatomy is mainly supported by the dissection of cadavers. However, in the face of transformations in the academic environment and technological innovations, this methodology has been rethought.[3] With recent advances in areas such as genetics, immunology and molecular biology, the workload of the discipline of human anatomy has been reduced, giving way to other topics of study.[4,5] Added to this are logistical, financial, and ethical restrictions for the receipt of cadavers by educational institutions, due to the scarcity of donations, the need for adequate infrastructure for the storage of anatomical specimens, as well as qualified professionals for the respectful and careful handling of this material.[6]

Thus, the use of technology represents a way to minimize the difficulties for the teaching of anatomy, and can be associated with different teaching approaches, which also aim to mitigate the impasses of the teaching-learning process and ensure the quality of teaching.[4,6]

The application of tools based on artificial intelligence, such as three-dimensional models of anatomical structures, the performance of ultrasound exams, and the analysis of other imaging exams, enrich the teaching of this topic, as they provide more dynamic and interactive learning, allowing students to better understand the concepts and practical experience closer to the clinical reality.[3,7]

Radiology, as a teaching tool, allows students to understand the anatomical position of the organs and structures of the human body in the context of diagnostic imaging. This, in turn, facilitates the recognition of changes and diseases.[8] Anatomical knowledge is essential to perform accurate analysis of imaging exams, which allow non-invasive evaluation of the organs and structures of the human body. They, in turn, allow the medical professional to establish diagnoses, prognoses and possible therapeutic conducts – fundamental competencies for the exercise of their profession.[9] Consequently, there is a positive impact on the quality of life of the patient, who benefits through early diagnosis and correct therapeutic measures, and has significant effects on public health – since the accuracy of diagnoses avoids wasting resources intended for health, making them better allocated.[10,11]

Thus, the objective of this study was to suggest an essential medical curriculum (core curriculum) in radiological anatomy of the chest, which establishes the fundamental structures to be identified in imaging examinations by a general practitioner, and which contributes to the teaching of anatomy and radiology in medicine, contributing to improve clinical practice.

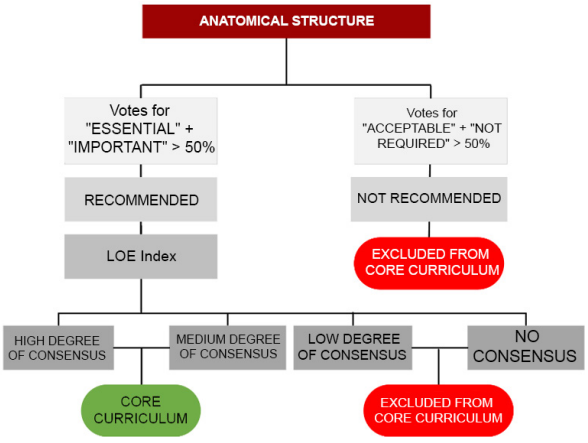
METHOD

The questionnaire was sent by e-mail to the physicians, professors and preceptors of the medical school of the Pontifical Catholic University of Paraná, Curitiba, PR, Brazil. Participants were invited to answer a form prepared by the authors. For this reason, the project was submitted to and approved by the Ethics Committee (opinion No. 5.429.625 and CAAE 58355522.3.0000.0020).

To develop the proposal for an "essential curriculum of radiological anatomy of the chest", the study followed a process divided into stages. The first was the literature review, using electronic databases, Lilacs, Scielo and PubMed. Advanced searches were conducted with the terms "Anatomy, Core curriculum and Teaching" to identify publications whose objective was the elaboration of human anatomy curricula.

From the selected publications, the structures considered relevant were listed. Next, those that were important in the context of radiology were evaluated, which allowed the formulation of the questionnaire.

A form was developed on the Google Forms platform, containing 94 anatomical structures of the thorax. The participants were asked to evaluate the relevance of each of them, in the sense that it could be identified by a general practitioner in a chest imaging exam. To perform this evaluation, the 4-point Likert scale was used, in which the participant had to select one of the following options: "essential", "important", "acceptable" and "non-required" (Figure 1).[12]



Source: Tubbs RS, et al.12

FIGURE 1 — Likert scale model

Finally, data analysis was performed, which was divided into 2 moments. Initially, all answers were included in an Excel® spreadsheet. As described, each anatomical structure could be classified into 4 forms: essential, important, acceptable and non-required. The classifications essential and important are related, and their percentages add up. If it was greater than or equal to 50%, the structure was considered recommended. On the other hand, the acceptable and non-required classifications are also related, and their percentages added together. In case the sum was greater than 50%, the structure was considered not recommended.[12]

Afterwards, the structures classified as recommended by the initial evaluation were submitted to the second analysis. For this, the percentage of responses in each of

the categories of the Likert Scale was verified for each recommended structure. This evaluation allowed the application of the Loe Index (Table 1), which establishes degrees of consensus based on the percentage of responses, and establishes 4 categories: high, medium, low and no consensus.[13]

TABLE 1 — Loe Index

High consensus	70% responses in 1 category or 80% in 2 related categories
Medium consensus	60% responses in 1 category or 70% in 2 related categories
Low consensus	50% responses in 1 category or 60% in 2 related categories
No consensus	Less than 60% in 2 related categories

Source: Shimizu HE and Fragelli TBO[13]

Thus, the recommended structures with a high or medium degree of agreement (those that obtained at least 60% of answers in essential or important or a sum between these 2 classifications greater than 70%) were selected to be part of the Core curriculum.[14]

RESULT

The form was answered by 26 professors and/or preceptors of the PUCPR medical course from 15 medical specialties (Table 2).

The form was structured in 4 sections, one for each type of imaging test, which included: posteroanterior chest X-ray, lateral view chest X-ray, lung window chest computed tomography, and mediastinal window chest computed tomography. All recommended structures with a high and medium degree of consensus are part of the Core curriculum.

TABLE 2 — Medical specialties participants

SPECIALTY	n
General surgery	3
Endocrinology	3
Cardiology	2
Digestive system surgery	2
Vascular surgery	2
Geriatrics	2
Gynecology and obstetrics	2
Pulmonology	2
Urology	2
Thoracic surgery	1
Gastroenterology	1
Family and Community Medicine	1
Paediatric oncology	1
Orthopedics	1
Otorhinolaryngology	1
TOTAL	26

In the first section, regarding posteroanterior chest X-rays, there were 25 structures to be evaluated. Of these, 11 (44%) were recommended with a high degree of consensus, 5 (20%) with medium degree, 4 (16%) with low degree, 2 (8%) were not recommended, and in 3 (12%) there was no consensus (Figure 2).

RECOMMENDED WITH HIGH CONSENSUS (CORE CURRICULUM)	RECOMMENDED WITH MEDIUM CONSENSUS (CORE CURRICULUM)	RECOMMENDED WITH LOW CONSENSUS	NOT RECOMMENDED	NO CONSENSUS
CHEST X-RAY IN PA VIEW				
- Clavicle - Posterior costal arches - Anterior costal arches - Diaphragmatic domes - Gastric bulla - Costophrenic sinuses - Pulmonary hila - Trachea - Right main bronchus - Left main bronchus - 3rd arch: left ventricle	- Scapulae - Acromion-clavicular - 1st arch: aortic button - 2nd arch: pulmonary trunk - Cardiophrenic sinuses	- Glenohumeral Art - Central Pulmonary A. - Intrapulmonary Vessels - Right Atrium	- V. azygos - Adipose cushion of the pericardium	
LATERAL VIEW CHEST X-RAY				
- Right ventricles - Aortic arch - Trachea - Sternum - Retrosternal space - Thoracic vertebrae	- Disc spaces	- Left atrium - Left ventricle - Retrotracheal space supra-aortic	- A. left pulmonary - V. inferior cava	-Bronchus For the wolf superior left
COMPUTED TOMOGRAPHY OF THE CHEST IN THE LUNG WINDOW				
- Trachea - Right main bronchus - Left main bronchus - Intrapulmonary vessels - Costophrenic sinuses	- Right Oblique Fissure - Left Oblique Fissure	- Horizontal crack		
COMPUTED TOMOGRAPHY SCAN OF THE CHEST IN THE MEDIASTINAL WINDOW				
- Trachea - Carina - Right main bronchus - Left main bronchus	- Esophagus - V. superior cava - V. inferior cava - Arch of the aorta - Ascending aorta - Descending aorta - Pulmonary artery trunk - Arches of the coast Vertebral body	- Brachiocephalic trunk - A. carotid artery left - A. left subclavian - A. right pulmonary - A. left pulmonary - Right atrium - Right atrium - Left atrium - Right ventricle - Left ventricle - Medullary canal - Spinal cord	- Right lobe of the thyroid - Left lobe of the thyroid thyroid - Isthmus of the thyroid - V. right brachiocephalic - V. brachiocephalic left - V. azygos - V. hemiazygos - V. accessory hemiazygos - Interatrial septum - Interventricular septum - Adipose cushion of the pericardium - M. pectoralis major - M. pectoralis minor - M. supraspinatus - M. infraspinatus - M. subscapularis - M. paravertebral - Scapula - Laminae	-Processes thorny - Processes transverse - pedicles - clavicles

FIGURE 2 — Core curriculum showing items that may or may not be identified with the analysis of radiological examinations

In the second section, regarding lateral view chest X-rays, there were 14 structures to be evaluated. Of these, 6 (42.8%) were recommended with high grade, 1 (7.1%) with medium grade, 3 (21.4%) with low grade, 3 (21.4%) were not recommended, and 1 (7.1%) did not reach consensus (Figure 2).

In the third section, regarding chest computed tomography in the lung window, there were 8 structures to be evaluated. Of these, 5 (62.5%) were recommended with a high degree of consensus, 2 (25%) with a medium degree, 1 (12.5%) with a low degree of consensus (Figure 2).

In the fourth section, regarding computed tomography of the chest in the mediastinal window, there were 47 structures to be evaluated. Of these, 4 (8.5%) were recommended with a high degree of consensus, 9 (19.1%) with medium degree, 11 (23.4%) with low degree, 19 (40.4%) were not recommended, and 4 (8.5%) did not have a consensus (Figure 2).

In all, 43 of the 94 structures initially listed were included in the Core curriculum.

DISCUSSION

Selection of structures

The process of selecting structures for inclusion was based on an extensive literature review. The articles used as a reference presented a methodology similar to the present study and had the objective of proposing an essential curriculum of human anatomy.[13] After the review, the structures considered relevant were selected to be evaluated. This evaluation was necessary because not all the structures observed in the anatomical specimens of cadavers are visible on imaging studies or have relevance in the clinical context.

Selection of participants

The inclusion criteria of the study were to be a professor and/or preceptor of the medical course at PUCPR, with a degree in medicine, with no restriction in relation to the medical specialty. This resulted in the participation of 26 doctors from 15 different specialties. The sample size was established based on studies that had a similar objective and methodology.[12,15] This strategy was determined for several reasons. One of them was that all physicians had undergone undergraduate studies, which offer minimum knowledge on the topic addressed in this study and, therefore, should have basic knowledge in this area to be able to evaluate the relevance of the proposed structures in the context of radiology. Restricting responses to experts in the field only—such as pulmonologists and thoracic surgeons—would reduce the sample size, which would affect the relevance of the results. Finally, there would be a bias from specialists, who could overestimate the structures since they are already part of their daily professional practice.

However, it is recognized that the strategy adopted has its limitations. Some specialties, such as obstetrics and urology, have little relation to the subject of the study. Therefore, evaluating chest imaging is not common in its daily practice. This may result in a possible underestimation of the importance of the structures by these physicians, whose previous knowledge of the subject could not be evaluated.[16]

Relevance of the theme for the general practitioner

The newly graduated physician has several possibilities of action and, as a generalist, the area of urgency and emergency gains prominence, with emphasis on the scenario of Emergency Care Units (UPAs) and emergency care in tertiary care.[17]

According to the document prepared by the National Council of Health Secretaries (CONASS) in 2015, which evaluated the impact of the implementation of the UPAS, it was found that 55.3% of the physicians interviewed and who worked in these units had completed their graduation less than 2 years ago. This reinforces the fact that many recent graduates have found job opportunities in area of urgency and emergency. In these environments, professionals are often faced with patients in serious condition; Therefore, it is necessary to establish quick and precise conducts.

Chest trauma represents a serious public health problem due to its high prevalence and significant morbidity and mortality. It is the second most common type of trauma, corresponding to 7.5% of all cases. It is also directly responsible for 1/4 of deaths and is indirectly associated with half of deaths due to trauma.[18-20]

Therefore, especially in the scenario of urgencies and emergencies, it is essential that the professional has knowledge about the normal pattern of chest imaging exams. This enables the accurate identification of abnormalities and, consequently, allows for early diagnosis and appropriate treatment of these diseases, contributing to better prognosis.[18-20]

Thus, in traumatic emergencies, the most frequently used exams are radiography and computed tomography, which justifies the choice of these exams for the present study.

X-ray is performed upon suspicion of chest trauma.[18] Although it is a less complex test, it is capable of diagnosing and guiding the medical team in the face of injuries that pose a risk to the patient's life, and for this reason, it is considered a screening test for serious injuries. In addition, it is more accessible and, therefore, may be the only radiological resource available.

On the other hand, CT scan has higher sensitivity, which means it can detect serious injuries with greater accuracy. However, due to exposure to ionizing radiation and its higher cost, it has more restricted indications, being reserved for cases that require a more detailed and specific analysis of the thoracic structures.[19]

In addition to traumatic emergencies, health professionals also use the exams in the face of clinical emergencies. Chest pain complaints are the second leading cause of seeking urgent and emergency services20, and about 80% have chest pain of extracardiac origin.[21] The initial investigation of chest pain in the emergency room, as well as pulmonary, pleural, and mediastinal complaints, is performed by chest X-ray in most cases. And, as with trauma, ultrasound and CT

scans may be used, depending on the presentation and clinical suspicion.[20,21]

A study conducted at a university in the United Kingdom evaluated the impact of incorporating radiology into the discipline of human anatomy in the first year of the course. To do so, the researchers compared the grades obtained in the evaluations applied at the end of the academic term for 5 consecutive years – during this period, radiology participated in the discipline schedule for 2 years. The results indicated that the introduction of imaging tests had a positive effect on the instruction of students, as well as on teaching in small groups.[22] In addition, the demonstration of different imaging exams allowed the students to understand which technology is most appropriate to highlight and analyze the anatomical structure of interest, which contributed to a better understanding of the subject.[23] This study highlighted the importance of using innovative approaches to improve the teaching of human anatomy, the development and autonomy of medical students.

Thus, radiography is essential for the rapid initial evaluation, while computed tomography presents the lesions in more detail, although it requires more careful indication due to the greater exposure to radiation and costs of the exam. The appropriate choice between these methods depends on the clinical picture and the specific needs of each situation. Due to its wide use, it is essential that professionals who occupy positions in urgent and emergency scenarios, such as newly graduated physicians are able to interpret these exams.

CONCLUSION

It was possible to develop a Core curriculum of radiological anatomy of the chest, consisting of 43 relevant structures to assist professionals in the evaluation of radiography and computed tomography examinations. This list highlights the fundamental structures to be identified in imaging studies by general practitioners, so that, when used as a teaching tool, it can not only facilitate the learning process, but also present the normal radiological aspect of these structures. Placed in clinical practice, it facilitates the identification of pathological alterations in imaging studies based on the knowledge of the normal state of anatomical structures, contributing to establish a better diagnosis and treatment of diseases related to the thorax.

Authors' contributions

Conceptualization: Laura Galliano de Barros
Investigation: Patricia Carla Zanelatto Gonçalves
Methodology: Eduardo Antônio Andrade dos Santos
Supervision: João Batista Rodrigues da Luz
Writing (proofreading and editing): All authors

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