Changing Times in Undergraduate Studies on Neuroanatomy

Tempos de Mudança no Ensino Pré-Graduado de Neuroanatomia

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KEYWORDS

– Medical Education;

– Curriculum;

– Neuroanatomy.

ABSTRACT

Undergraduate medical curricula are currently undergoing a process of reform, with such changes including the field of neuroanatomy. In this context, the purpose of our study was to assess the status of undergraduate neuroanatomy studies in Portuguese medical schools to provide a basis for a more informed discussion on the curricular changes. With all seven Portuguese medical schools participating in the study, four of them were shown to incorporate a modern integrated curriculum and the other three a conventional discipline-based curriculum. Our study therefore shows that neuroanatomy is approached differently according to each institutional culture. The great variability in neuroanatomy studies across medical schools emphasizes the need for the creation of a national core curriculum on undergraduate neuroanatomy.

PALAVRAS-CHAVE

– Educação Médica;

– Currículo;

– Neuroanatomia.

RESUMO

A educação médica pré-graduada está a passar por um processo de reforma, levando a algumas mudanças curriculares, que incluem a neuroanatomia. Neste contexto, o objetivo do nosso estudo foi avaliar o estado da educação pré-graduada neuroanatómica nas escolas médicas portuguesas para fornecer uma base para uma discussão mais informada sobre a revisão curricular. Todas as sete escolas médicas portuguesas participaram do estudo. Quatro delas refletem um currículo integrado moderno, e as outras três um currículo convencional baseado na disciplina. O nosso estudo mostra que a neuroanatomia está sendo abordada de forma diferente de acordo com cada cultura institucional. A grande variabilidade na educação neuroanatómica nas escolas médicas enfatiza a necessidade de criar um currículo nacional para a neuroanatomia pré-graduada.

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INTRODUCTION

In recent decades the paradigm of medical education has changed considerably in its priorities, contents and methods[1,2,3]. At the European level the big booster of this paradigm shift was the Bologna process[4], which aims to integrate and harmonize the European Higher Education Area. In this context, undergraduate medical education is undergoing a reform process that is moving away from a conventional (discipline-based) curriculum towards a modern (i.e., integrated system-based) curriculum[5]. Portuguese neuroanatomy teaching and learning is affected by these European curricular innovations and although Portuguese medical schools are revamping their neuroanatomy curriculum, it is still difficult to determine which model is the best. Nowadays, there are no national guidelines to help decide which is the minimum level of neuroanatomy knowledge that should be required to students or what is the core curriculum content. In this context developing and supplying data related to current status of undergraduate neuroanatomy education in Portuguese medical schools is essential, as this kind of information can help course directors and teaching faculty making changes and improvements to their educational programs.

MATERIAL AND METHODS

A semi-structured interview was developed and conducted to gather information about neuroanatomy courses in Portuguese medical schools during 2013. The members of faculty responsible for teaching neuroanatomy at each medical school were asked about the nature of their curriculum, the place of neuroanatomy within the medical curriculum and the amount of contact hours, the curriculum content, the teaching methodology, the resources used, the staff involved and the assessment methods used.

RESULTS

All seven medical schools (100%) who delivered 6-year courses of Medicine participated in the study (Table 1).

Table 1
Medical schools participating in the study

Faculty of Health Sciences of the University of Beira Interior
Faculty of Medicine of the University of Coimbra
Faculty of Medicine of the University of Lisbon
Faculty of Medicine of the University of Porto
Faculty of Medical Sciences of the New University of Lisbon
Institute for the Biomedical Sciences Abel Salazar of the University of Porto
School of Health Sciences of the University of Minho

Nature of their curriculum

From the seven Portuguese medical institutions, three (43%) reflect a conventional medical curriculum, with neuroanatomy representing an isolated course. The remaining four institutions (57%) adopt a modern medical curriculum, integrating neuroanatomy with other subjects, namely neurophysiology (three courses), neurohisthology (three courses), neuropharmacology (two courses), psychology (two courses), neurochemical (two courses) and neuroradiology (one course).

One of the medical schools that reflects a modern curriculum is integrated within a "spiral" model of curriculum design, where neuroanatomy is revisited multiple times with increasing complexity to reinforce learning. In the remaining three medical schools that adopt a modern medical curriculum, building blocks are part of the curriculum and neuroanatomy instruction is based on a comprehensive "module" covering nervous system.

Place of neuroanatomy and the amount of contact hours

The place of neuroanatomy within the medical curriculum is shown in Table 2.

In all the courses reflecting a conventional curriculum, neuroanatomy was taught in the 2nd year.

In the three medical schools adopting a modern "modular" curriculum, neuroanatomy was also taught in the 2nd year. In the only medical school that reflect a modern "spiral" curriculum neuroanatomy was taught in the first, in the third and in the fifth year, allied to the clinical neuroscience courses.

We also explored the approximate number of contact hours of neuroanatomy per year (Table 2). The average total number of contact hours within medical schools following a conventional curriculum was 61h (minimum 56 and maximum 70) and in those adopting a modern curriculum was 21.3h (minimum 7 and maximum 32).

Table 2
Place and average number of contact hours of neuroanatomy per year in conventional and modern curriculum courses (min/max)

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Conventional curriculum courses (n = 3)		N/A	61h (56/70)	N/A	N/A	N/A	N/A	61h
Modern curriculum courses (n = 4)	"Modular" curriculum (n = 3)	N/A	21.3h (17/32)	N/A	N/A	N/A	N/A	21.3h
	"Spiral" curriculum (n = 1)	8h	N/A	7h	N/A	7h	N/A	22h

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Curriculum content

Central nervous system (CNS) was included in the neuroanatomy content of all the curricula. Peripheral nervous system (PNS) was part of the neuroanatomy content in 33.3% of medical schools adopting a conventional curriculum and in 50% in those reflecting a modern curriculum, while esthesiology was part of the neuroanatomy content in 33.3% of medical schools adopting a conventional curriculum and in 75% in those reflecting a modern curriculum.

Teaching methodology

In medical schools following a conventional curriculum the lecture method was the most common instructional model, being used in 100% of the institutions; 66.6% of medical schools that reflect a conventional curriculum also used practical classes and seminars as teaching methods. Theoretical-practical classes were used in 33,3% of the institutions.

Lectures and practical classes (prossections at the Anatomical Theater) were used in 75% of the medical schools adopting a modern curriculum and seminars in 50%. In 25% of the institutions reflecting a modern curriculum there were also theoretical-practical classes. One of the medical schools also used integrated and cross-cutting activities that include lessons shared between various disciplinary areas and a mini-congress of neurosciences. In these mini-congress, students organized in small groups, presented a topic, treated in an integrated way and in relation to what is taught in various disciplines. Noteworthy that one of the schools adopting a modern curriculum focuses on a problem-based learning through clinical cases ("phase I, II and III" classes). In "phase I" classes some clinical cases are presented and discussed in order to show students what must be their objectives during that module. "Phase II" classes are practical classes arising in the anatomy laboratory and in the clinical skills laboratory and include learning the neurologic examination. In "phase III" classes teachers present clinical cases and discuss them with students.

Resources used

In medical schools adopting a conventional curriculum the most frequently used resource for teaching neuroanatomy was human cadaveric material, being used in "most sessions" in 66.7% of courses and in "some sessions" in 33.3%. In medical schools adopting a modern curriculum, human cadaveric material was used in 75% of courses in "some sessions", with 25% of courses using it "rarely".

In both curriculum types, neuroanatomical models were used to teach neuroanatomy in "some sessions".

Computed-based 3D tools were used "rarely" in medical schools adopting a conventional curriculum, but in "most sessions" in medical schools adopting a modern curriculum.

All the medical schools adopting a modern curriculum used medical imaging [magnetic resonance imaging (MRI) and computed tomography(CT)], in "most sessions". From the medical schools adopting a conventional curriculum 66.7% used it in "some sessions" and 33.3% "rarely".

Faculty staff

The majority of faculty staff involved in teaching neuroanatomy, in both curricula types, was part-time clinicians, clinically related to neurosciences (62.5% in medical schools adopting a conventional curriculum and 45.8% in medical schools reflecting a modern curriculum). Other part-time clinicians, not clinically related to neurosciences participated in the teaching process (31.3% in medical schools adopting a conventional curriculum and 35.4% in medical schools reflecting a modern curriculum). In both curricular types full-time academic staff was rarely involved in teaching neuroanatomy (6.3% in medical schools adopting a conventional curriculum and 2% in medical schools reflecting a modern curriculum). In 16.7% of medical schools adopting a modern curriculum there was also part-time non-clinician staff, namely biochemists and biologists.

Assessment

In one of the medical schools adopting a conventional curriculum (33.3%) the assessment was the result of continuous assessment (two practical assessment tests of identification of neuroanatomical structures, corresponding to 20%) plus final examination (oral examination, corresponding to 80%). In another medical school adopting a conventional curriculum the assessment consisted in a practical assessment (two moments of identification of neuroanatomical structures, corresponding to 10%) plus a final theory examination (written examination, with multiple-choice questions, discounting the wrong answers, corresponding to 90%). However, in this institution, students have the option to replace the final examination by two mini-tests. In another medical school adopting a conventional curriculum there was a distributed and a final assessment. The distributed assessment consists in a practical evaluation (two examinations of identification of neuroanatomical structures) and a theoretical evaluation (two written examinations with multiple-choice questions) plus a continuous assessment, depending on the frequency and quality of participation of the students in practical classes.

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In all the medical schools adopting a modern curriculum (100%) neuroanatomy assessment was integrated with other basic medical sciences, through an integrated written examination, where multiple-choice questions integrated subjects approached in the various disciplines and were distributed in order to uniformly cover all areas of knowledge. Two of the schools adopting a modern curriculum (50%) also required students to complete and pass a specific neuroanatomy assessment before progressing to the final integrated examination. In one of these schools the specific neuroanatomy assessment consisted in a continuous assessment of the lessons plus a global practice (oral) test with weighting, respectively, of 20% and 80% and in the other one it included a practice (skills component) and a theoretical test (knowledge component) corresponding, respectively, of 40% and 60%.

DISCUSSION

Medical education has changed profoundly in recent decades [6]. Some of the changes are justified by the increasing complexity of scientific knowledge and by the improvement of technological means, leading to an emphasis on teaching medical students to effectively access and manage information and apply the knowledge in the clinical setting[7,8]. Thus, a multimodal approach to education involving active learning, contextual learning of applied basic medical sciences, and longitudinal and vertical integration of curricula with assessment of competencies is the current pedagogical goal[9,10].

Anatomy education has always been regarded as an essential requirement in the medical curriculum[11]. By learning anatomy, medical students get a first vision about the structure of the human body, which is the basis for understanding pathology and clinical problems.

Neuroanatomy, due to the complexity and specificity of the nervous system, differed from the general anatomy and took its own place in the curriculum[12]. Having been accepted as an area of knowledge and acquisition of key competencies for clinical neuroscience[13,14], neuroanatomy is included in all European medical curricula.

However, neuroanatomy curriculum is changing[15] and Portuguese medical schools continue to adjust and modify their programmes.

In this study we compared the undergraduate neuroanatomy education in Portuguese medical schools, to provide data to promote more conscious decisions in a period of curricular revision.

Our results indicate that there is considerable variability in neuroanatomical instruction in Portuguese medical schools, especially when comparing medical schools adopting a conventional curriculum and medical schools that reflect a modern curriculum.

In our study we found that, although neuroanatomy is taught in the 2nd year in most of the medical courses, the average contact hours related to neuroanatomy is significantly lower in medical schools adopting a modern curriculum. This reduction in teaching hours is seen in almost every basic science across the world. In places like United States, United Kingdom, Ireland, Australia and New Zealand, anatomy teaching hours has declined sometimes by as much as 80%[16,17,18]. In the United States, over the period from 2002 to 2009, the instruction hours for neuroanatomy had declined from 96±37 to 79±33 hours, respectively, representing an 18% decrease[19,20,21]. Supporters of the conventional curriculum are afraid that this reduction in workload leads to a decrease in the amount of neuroanatomical knowledge. However, a reduction in teaching hours does not necessarily equate to a reduction in knowledge. Whillier and Lystad[22] found that an increase in total hours of face-to-face teaching did not improve student grades. For the advocates of the modern curriculum what is important is that students acquire a sufficient knowledge base adequate for clinical practice.

Instruction of neuroanatomy encompasses multiple subdomains and forms of representation and the curriculum may include, besides the CNS, the PNS and esthesiology. In a time of curricular and course revision some medical educators argue that anatomy curriculum (including neuroanatomy) should focus on a core curriculum of the most clinically relevant topics[23,24]. Moxham et al.[25], in their recent paper, described an approach, consisting in three stages, towards the development of core syllabuses for the anatomical sciences, providing preliminary findings relating to neuroanatomy. At the initial stage, an expert Delphi panel was composed consisting of about 20 persons from different countries, including one from Portugal. Delphi panel prepared and evaluated item/topic from a detailed list according to whether it has "essential", "important", "acceptable", or "not required" status, the aim being to devise a syllabus containing the core minimum knowledge deemed acceptable for a minimally competent student. In the stage 2 (consultation stage), anatomical and other cognate societies plus clinical authorities commented on Delphi panel's findings. In the stage 3, members of the anatomical societies and students were invited to participate in reviewing the proposed core syllabus. After a period of no more than 6 months the findings are further evaluated by the original Delphi panel, together with the IFAA's FIPAE. The items arethen published for general consumption through the internet.

Teaching an undergraduate neuroanatomy course can be challenging, due to the sheer complexity of the organization

of nervous system[26]. As neuroanatomy encompasses diverse anatomical levels (ranging from microscopic to macroscopic to gross anatomy), it tends to require a more systemic approach rather than a regional or topographic perspective as is often the case in many anatomy courses. Given these challenges, many studies have described pedagogical methods that go beyond the conventional lecture method of teaching neuroanatomy[27,28,29]. The goal is to promote critical thinking and relate learning to real world scenarios, such as those found in clinical settings. Today, as a result of this, many medical schools have incorporated active learning methods such as case studies-based learning[30], problem-based learning (PBL)[31,32], inquiry-based teaching[33], equivalence-based instruction[34] and computer-based learning[35,36] into their courses, where the main feature is the integration of different basic science disciplines in one course. In our study a shift was clearly visible from conventional education, with lecture-based teaching, to modern education, with a more interactive approach.

Traditionally, teaching anatomy has been dissection--based, with human cadaveric material being the paradigm of anatomy teaching since the Renaissance. However, human dissection has been gradually abandoned in anatomy curriculum[37]. The enormous technological advances allowed to obtain computer-generated images, with multiplanar (virtual 3D) models, that facilitate and improve teaching and learning of anatomy, including neuroanatomy[38,39]. Noninvasive imaging techniques[40], such as MRI and CT, besides becoming more important diagnostically, also allows in vivo anatomy study, promoting links to clinical practice. Our study reflects these changes, showing that medical schools adopting a modern curriculum used more computed-based 3D tools and medical imaging (MRI and CT) and less human cadaveric material than medical schools following a conventional curriculum.

Our study reports that the majority of faculty involved in the teaching/learning process of anatomy in Portuguese medical schools, in both curricula types, are part-time clinicians, clinically related to neurosciences. Historically practice of neuroanatomy instruction was by full-time career anatomists. Nowadays, however, as the aim is to give clinical relevance to neuroanatomy teaching, clinicians clinically related to neurosciences seem to be the best educational option (if even being part-time staff).

In both curriculum types the most frequently used mean of assessing neuroanatomy was written examination with multiple-choice questions. The big difference is that in medical schools that reflect a modern curriculum assessment is integrated with other basic medical sciences. To prevent students to pass the integrated examination performing very poorly in neuroanatomy, but well in other subjects, 50% of the portuguese medical schools that adopted a modern curriculum have also a specific neuroanatomy assessment previously to the integrated examination.

CONCLUSION

In Portugal there are no national guidelines for the teaching of neuroanatomy, with each individual institution defining their own curriculum content, teaching methodology and assessment. This considerable variability in neuroanatomy content led to concerns regarding the possibility of also existing variable depth of understanding of neuroanatomy between graduates of different medical courses, emphasizing the necessity to create a national core curriculum for undergraduate neuroanatomy with the participation of all the Portuguese medical schools, Portuguese medical association with the allied cooperation of the colleges of specialty of neurology, neurosurgery, psychiatry and neuroradiology.

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CONTRIBUTIONS TO THE AUTHORS

Mavilde Arantes collected and analyzed data and wrote the article. Maria Amélia Ferreira guided every step of the work and conducted a critical review. Both authors approved the final version.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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