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Development of an Undergraduate Radiology Curriculum: Ten-Year Experience From the University of British Columbia

Kathryn E. Darras, MD^{a,*}, Sheldon J. Clark, MD^a, David K. Tso, MD^a, Teresa I. Liang, MD^a,
Claudia Krebs, MD, PhD^{a,b}, R. Petter Tonseth, MD, FRCPC^{a,c}, Silvia D. Chang, MD, FRCPC^{a,d},
Bruce B. Forster, MD, FRCPC^{a,d}, Savvas Nicolaou, MD, FRCPC^{a,d}

^aUniversity of British Columbia, Vancouver, British Columbia, Canada

^bDepartment of Cellular & Physiological Sciences, Faculty of Medicine, Vancouver, British Columbia, Canada

^cDepartment of Nuclear Medicine, British Columbia Cancer Agency, Victoria, British Columbia, Canada

^dDepartment of Radiology, Vancouver General Hospital, University of British Columbia, Vancouver, British Columbia, Canada

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Exposing medical students to the specialty of radiology is essential for recruiting excellent residents and cultivating an early understanding of the value of radiology in clinical practice. Several studies have demonstrated that medical student engagement at the undergraduate level—through teaching, research, and mentorship—plays an important role in determining students' choice of residency [1–4]. However, undergraduate medical curriculum development teams across the country often do not include a radiologist. This results in heterogeneous teaching that frustrates students and dampens their enthusiasm for our specialty.

The need for a unified undergraduate radiology curriculum was recognized at the University of British Columbia (UBC) over a decade ago. At that time, we conducted a national survey to identify the status of undergraduate radiology teaching in Canada. This survey identified a general lack of a unified syllabus, which resulted in redundant content, gaps in knowledge, and lack of continuity in medical school radiology curricula [5]. We were fortunate that the UBC medical school was undergoing curriculum renewal at that time and we were able to negotiate for lecture and laboratory time to try to address some of these deficits at our institution. Over the last 10 years, the radiology undergraduate curriculum has become an integral aspect of the UBC

medical student experience. The purpose of this article is to highlight the challenges that we have encountered while implementing this curriculum and to provide some solutions we have found helpful in overcoming these obstacles.

Medical students will be taught imaging and it is vitally important to our specialty that we are the ones who teach it. This mandate was recognized in 2016 at the 79th Annual Scientific Meeting of the Canadian Association of Radiologists, during which the Undergraduate Education Chairs from across Canada met to call for a national undergraduate radiology curriculum. Although not without challenges, such collaborative efforts are essential in developing high-quality teaching and cultivating an interest in radiology among medical students.

Curriculum Design

The UBC medical undergraduate program (MDUP) is a 4-year program. The first 2 years are primarily preclinical, the third year is a standardized rotating clerkship, and the fourth year is a clinical elective year. Although the UBC MDUP is primarily based out of Vancouver, it is a distributed program with students also situated in Prince George, Kelowna, and Victoria. One of our challenges has been to standardize the content and delivery of the curriculum across all these sites.

The undergraduate radiology curriculum was designed to equip graduates with the skills needed to interpret basic studies and to appropriately order imaging tests as most students will not become radiologists. We began by developing a set of lecture or course objectives and exit

* Address for correspondence: Kathryn E. Darras, MD, University of British Columbia, 3350-950 W 10th Avenue, Vancouver, British Columbia V5Z 1M9, Canada.

E-mail address: darraske@gmail.com (K. E. Darras).

competencies, which were kept broad to facilitate their incorporation into the curriculum ([Appendix 1](#)). The objectives were originally based on the Association of Medical Student Educators in Radiology curriculum [6] and have since evolved to include competencies related to the Canadian Medical Education Directives for Specialists framework [7]. The focus in the preclinical years is have students identify normal anatomic structures and understand the imaging modalities. The focus in the clinical years is to have students on recognize basic pathology and understand imaging appropriateness. The MDUP curriculum is structured as a spiral curriculum where learners revisit the same topics multiple times over their 4 years, with increasing complexity at each visit [8].

The key to the successful implementation of our curriculum was in the creation of a UBC Radiology Undergraduate Medical Education Committee, which comprised medical students, residents, and staff radiologists who shared a passion for education and recognized the need for improved radiology exposure at the undergraduate level. This committee continues to meet quarterly to review and improve the curriculum (including physical and electronic resources, didactic lectures, and electives) and provide a forum to present and discuss concerns related to undergraduate education. This committee's mandate is also student engagement, including career planning, mentorship, and maintenance of a database of research and audit opportunities. We would highly encourage all institutions to centralize undergraduate educational activities (eg, content development, lecturer assignments) through a central committee to oversee quality and eliminate redundancy.

Preclinical Years

At our institution, radiology plays a central role in the preclinical years including an integrated radiological or gross anatomy course, didactic lectures, case-based learning (CBL), and clinical skills.

Radiological Anatomy

Since 2011, the UBC anatomy curriculum has been integrated, including teaching students both radiological and gross anatomy [9]. This has been enhanced throughout the years based on student evaluations of the course. In the preclinical years, medical students currently receive 37 hours of anatomy lectures and 82 hours of lab time for cadaveric dissection, in addition to self-directed online modules. Lecture time is split between gross and radiographic anatomy. Students typically have a gross anatomy lecture, followed by a related radiological lecture, and then by the corresponding cadaveric dissection. In the gross anatomy laboratory, iPads connected to large screens allow students to review the radiological anatomy during cadaveric dissections. An example of this integration is shown in [Table 1](#).

The radiological anatomy component follows a flipped-classroom structure in which students are expected to review an integrated online module before the session to introduce key concepts. Modules ([Figure 1](#)) were created using the Articulate Storyline Software (Articulate, New York, NY) and hosted on our departmental website, where they are free to access [10]. We obtained a license agreement to use the images from the Visible Human Project in order to develop correlation modules between gross and radiological anatomy ([Figure 2](#)) in addition to radiology anatomy modules [11]. There was no cost associated with obtaining this license agreement.

This flipped-classroom format has been well received by medical students. In 2013, this integrated radiological anatomy and gross anatomy course was formally assessed by the MDUP through course evaluations. At this time, 98% (238 of 242) of first year students identified the online modules helpful for learning anatomy, and 96% (234 of 243) claimed that lectures alone were insufficient to learn radiological anatomy. Students liked the flexibility of access and most importantly, interactivity of the modules. Indeed, 90% (222 of 247) of students preferred the more interactive modules compared to the point-and-click

Table 1
Integrated radiological and gross anatomy during first semester of year 1 at the University of British Columbia

Gross anatomy lecture	Radiological anatomy lecture	Cadaveric dissection	Online module
The body as a segmented system	Imaging the spine	Deep dissection of the back and spinal cord	The spine part I & II
Overview of the pectoral region	Mammography	Dissection of the Anterior Chest Wall and Breast	No module
Anatomy of the thorax: pleural cavities, thoracic walls and lungs	Imaging the chest	Dissection of the thoracic walls pleural cavities and lungs	The chest part I: radiography &
The mediastinum	Imaging the mediastinum	Dissection of the superior and posterior mediastinum	The chest part II: cross-sectional imaging
Anatomy and embryology of the heart	Imaging the heart	Dissection of the middle mediastinum and heart	The heart
Anatomy and embryology of the foregut	Imaging the abdomen: radiography	Dissection of the foregut	The abdomen part I: radiography
Anatomy and embryology of the midgut	Imaging the abdomen: CT	Dissection of the midgut	The abdomen part II: cross-sectional
Anatomy of the urogenital system	Imaging of the retroperitoneum	Anatomy of the urogenital system	The abdomen part I & II (review)
The male and female pelvis	Imaging of the pelvis	The male and female pelvis	The abdomen part III: pelvis
The male and female perineum	Review of body imaging	The male and female perineum	No module

CT = computed tomography.

The online modules can be found on the University of British Columbia undergraduate studies website [10].

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