Undergraduate radiology education in the era of dynamism in medical curriculum: An educational perspective

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Abstract

Radiology undergraduate curriculum has undergone a tremendous transformation in the decades reflecting a change in the structure, content and delivery of instruction. These changes are not unique to the discipline, but rather a response in the cycle of the re-engineering process in the medical curriculum in order to ensure its proper role into the ever-changing context. Radiology education is now more integrated across the curriculum than ever. The diversity of how radiology is being taught within the medical undergraduate curriculum is extensive and promising with the expanding role of the radiologist in the spectrum within the medical curriculum. A strong interface between the medical student and the clinicians must always be integrated in the learning process in order to convey the essential and practical use of the different aspects of radiology essential to the student’s career as a future clinician. With the recent advancement in educational and technological innovations, radiology education is mobilized in the most pioneering ways, stimulating a rekindled interest in the field of medical imaging. This paper describes the increasing interest in current role of undergraduate radiology education in the context of constant medical curriculum innovations and in the digital age.

1. Introduction

Radiology undergraduate curriculum has undergone a tremendous transformation in the decades reflecting a change in the structure, content and delivery of instruction. These changes are not unique to the discipline, but rather a response in the cycle of the re-engineering process in the medical curriculum in order to ensure its proper role into the ever-changing context. Schools and faculty are often faced with the need to develop and implement innovative curricula rapidly [1]. In several contextual settings, The change in medical curriculum is driven by factors, which among others, include “(1) exponential growth in both science and medicine knowledge, (2) changes in health care delivery and legislations, (3) the growing and reasonable public expectations that doctors will listen accurately to patient concerns and communicate effectively to form a therapeutic partnership and importantly, (4) the need to inculcate a philosophy of independent adult lifelong learners” [2].

In fact, the General Medical Council in United Kingdom has recommended that learning through curiosity, exploration of knowledge and the critical evaluation of evidence should be promoted, and should ensure a capacity for self-education [3]; the undergraduate course should be seen as the first stage in the continuum of medical education that extends throughout the professional life [4].

Many medical schools consistently revisit all aspects of their curricula to make sure it is in touch with the needs of the current times. Focus is given not only to the map, but more attention and emphasis is also given on the learning style and behavior of the student within program. Rote memorization has been downgraded in the shift to active learning, small-group exercise, team-based learning, problem-based learning and other interactive modes [5]. Within these perspectives, the discipline of radiology is cast within the tenets of the re-engineered student-focused medical curriculum. Radiology education is now more integrated across the curriculum than ever. The diversity of how radiology is being taught within the medical undergraduate curriculum is extensive and promising, although infamous compared to postgraduate radiology training. In the literature, there is an increasing number of articles in radiology education being published, although, mostly related to resident training with a decrease in focus on medical students [6].
There is the expanding role of the radiologist in the spectrum within the medical curriculum. The role of the radiologist will probably increase in future, teaching anatomy [7]. Not only are they confounded to the classical reading of plates in basic radiology courses, but there is the increasing involvement of the specialist in cross-sectional anatomy, taught by the experienced radiologist within the academic rank.

With the recent advancement in educational and technological innovations, radiology is mobilized in the most pioneering ways, stimulating a rekindled interest in the field of medical imaging. The digital revolution makes radiology an ideal setting for the development of web-based teaching tools. An integration of computers with small and large didactic instruction allow optimal use of faculty, conform to accepted theories of adult learning and are well accepted by students [8]. The broad dissemination of picture archiving and communications systems (PACS) is making such images readily accessible to medical schools, providing new opportunities for the incorporation of diagnostic imaging into the undergraduate medical curriculum [9].

This paper describes the increasing interest in current role of undergraduate radiology education in the context of constant medical curriculum innovations and in the digital age. We explain how undergraduate radiology education is affected as it adapts to the paradigm shifts in both curriculum design and student learning, with sample case studies to illustrate the point. We explore the advantages of the digital world and describe the different strategies undertaken on how this new media is being used to enhance instruction and learning. More importantly, we integrate vital educational philosophies underlying each perceived phenomena identified in these processes.

2. The dynamism explained: why is there a need for a change in the medical curriculum?

Change is good. According to Winston Churchill, “There is nothing wrong with change, if it is in the right direction”. In the past decades, there has been a felt transformation of the medical curriculum to reflect its purpose in the context of the contemporary medical community. Change happens if there is a demand to address the current needs of the stakeholders in the proper context, within the right direction. In the general curriculum, “The changing educational environment, the diverse educational needs of students, the high expectations from the public, and the policy reports demand strongly educational change not only at the education system level but also at the school-based level in local and international contexts” [10]. Curriculum change does not happen overnight, it is a continuous process which involves all stakeholders involved in consultations and research to address the current situation and identify if there is a need to challenge the current curriculum, if it serves its purpose. Ideally, according to Lachiver & Tardif, “curriculum change is managed in a logical five-step process: 1, an analysis of the current offerings and context; 2, the expression of key program aims in a mission statement; 3, a prioritization of resources and development strategies; 4, the implementation of the targeted curricula change; and 5, the establishment of monitoring tools and processes” [11]. In the context of the innovations in medical curriculum, these approaches aims “to produce medical professionals that could meet the future healthcare needs of society, locally and globally” [12] and “to prepare students to provide health care in an era of rapidly changing technology and fiscal constraints while emphasizing state of the art clinical knowledge, continued learning skills, early clinical experience, assessment of competence and professionalism” [13]. Like in any transformation within the academic curriculum, the medical curriculum molds itself to not only to deliver academically competent students as an output, but making sure that the students themselves are adapted and prepared to the challenges it faces after, effecting appropriate outcomes within the community they are addressing.

Changes in the medical curriculum is a dynamic process, with early suggestions for a reform since the early 1900s as can be seen in the Abraham Flexner’s Report Medical Education in the United States and Canada published in 1910 [14,15]. Collectively, Ludmerer stated the important key educational viewpoints and components in Flexner’s report: medical positivism, rigorous entrance requirement, the scientific method, learning by doing and original research [15]. Of special note, Abraham Flexner’s 1910 report, stated the importance of independent and active student learning, a paradigm shift from student as passive learner, to an active one, a ground stone for lifelong learning.

In line with the emphasis made on the need for a more active participation of the students in the learning process within the medical curriculum, General Medical Council (UK) in its publication, Tomorrow’s Doctors 2009: Outcomes and Standards for Undergraduate Medical Education, emphasized among others, the important duties and responsibilities of doctors: acquire, assess, apply and integrate new knowledge, learn to adapt to changing circumstances and ensure that patients receive the highest level of professional care; and establish the foundations for lifelong learning and continuing professional development, including a professional development portfolio containing reflections, achievements and learning needs [3]. Overall, the above points to the holistic purpose of revising the curriculum: address the needs of the society by a revision and improvement in content and delivery as it applies to the current context, whilst placing strong emphasis on the individuality of students to be molded into independent active responsible adult learners in program and beyond.

Interestingly, nearly 100 years after the Flexner report was published, the Carnegie Foundation for the Advancement of Teaching recently published another report on medical education: “Educating Physicians: A Call for Reform of Medical School and Residency” and based on the study’s key findings, “the team recommends four goals for medical education: standardization of learning outcomes and individualization of the learning process; integration of formal knowledge and clinical experience; development of habits of inquiry and innovation; and focus on professional identity formation” [16]. This is an affirmation of the constant need to reform the curriculum pillars as dictated by the society’s situation and needs.

The change in the medical curriculum is not exclusive in a society, but rather reflects a trend occurring worldwide as a response to the contextual needs. Examples listed below illustrate the point of the changes but do not reflect the generalized trend to the specificities of the change:

2.1. Case in point

2.1.1. Australia

Australian medical training, once confined solely to the largest cities with traditional curricula based on European educational models, has in the last 25 years become distributed, far-flung and highly diverse, with a mixture of problem-based learning and increasing vertical integration of disciplines across phases and years of training. With this transformation of medical education in Australia has come the need to exploit technology for content delivery, and to create new approaches to the teaching and training of doctors.

2.1.2. The University of Sydney Medical Program

The Sydney Medical School at the University of Sydney was established in 1850 and is Australia’s oldest medical school. Once teaching only at large hospitals in Sydney, it now has students across a wide range of healthcare settings, with 5 major clinical
schools that include urban, regional and rural hospitals, subspecialist hospitals and even private medical practices. Students may be posted for extended periods to centres up to 750 km from Sydney. Medical student teaching at such sites is highly dependent on face-to-face tutorials and other locally delivered teaching, but also strongly relies on technologies such as video-conferencing, video delivery of lectures, online delivery of curricular elements including lectures, and other digital teaching resources.

Prior to 1997, the Sydney medical course was a 5-year program with direct entry from high school, discrete preclinical and clinical phases and traditional lectures, tutorials and face-to-face teaching. Problem-based learning (PBL) and use of modern communications and online technologies was virtually nonexistent.

In 1997 a 4-year Graduate Medical Program was introduced. This was one of the first medical programs to rely on digital delivery of curricular content to an increasingly far-flung medical student body. The Program relies heavily on an integrated system of content management and delivery that spans all disciplines and that includes PBL, recorded lectures, teaching and learning materials, formative assessments and other digital resources. More than 10 years of development have led to a rich set of learning resources, yet in radiology this is still relatively weak. The new curricular concept at launch, which promoted integrated teaching at the bedside, meant that radiology was relegated to a very minor role that belied its rapidly increasing importance in medical practice. Radiologists at some clinical schools fought for and won face-to-face teaching time, but this was not embraced fully by the curriculum and faculty administrators until very recently. Radiology was not the only discipline to suffer; the traditional bastion of anatomy was dramatically reduced under this program as well [17–20].

### 3. Radiology education today

#### 3.1. Why teach radiology?

Radiology is one medical specialty, which shows a rapid advancement in technology coupled with breakthroughs mainly in aiding modern disease diagnosis. A modern medical school curriculum must be able to adapt to these advances as well as providing a sound foundation in radiology so that its graduates are well prepared as they begin their postgraduate training, regardless of which field they may be entering [21]. As mentioned previously, the timely evaluation of radiology education in the context of the medical curriculum is vital in order to bring forth enhanced outcome-based education to medical students in clinical context.

"Today, Imaging is not just a major influence in medicine; it is now indispensable to all of medicine".

Crowe, J., Presidential Address, ARRS 2008

John Crowe’s address could not more emphasize on the important role of radiology and medical imaging in the society. The vital role of radiology in the contemporary clinical practice cannot be underestimated albeit this does not appear to be proportional to teaching hours if we examine most medical curriculum. Radiology has expanded its role in the clinical practice as fast as new technologies in this field are made: with newer and combined modalities emerging in the recent years addressing the expanding clinical needs of the patient. In most cases, the curriculum cannot cope up with these developments. However, despite revisions in the overcrowded medical curriculum to address the needs of the current times, the pressing emphasis in radiology education is not reflected in most cases, with disproportionate teaching hours spent in this specialty, compared to other mainstays of medical education.

Zafar in his article in Medical Teacher *Radiology: an underutilized resource for undergraduate curricula* mentioned that “although 80% of US medical schools have introduced radiological anatomy in their anatomy courses, with large proportion of final evaluation comprising questions in radiologic anatomy, the actual contributions of radiology to these teachings remains a mere 5%" [35]. Gunderman et al. pointed out several reasons emphasizing on the need for the expanded and integral role of radiology in the medical education of students: “(1) radiology provides the context for the contemporary physician to encounter frequently the internal anatomy of the human body, (2) radiology provides students with some of the most striking vistas in all of medicine, (3) radiology enjoys an unparalleled opportunity to play an integrative role in contemporary medical education as most contemporary medical specialties would be rendered unrecognizable without the regular input of diagnostic imaging, (4) radiology provides an excellent forum in which to teach some of the most basic principles of medical reasoning, (5) radiology provides an excellent forum in which to address the widely neglected topics of health promotion and (6) through radiology, students can be taught the importance of communication, a vital but frequently neglected art in contemporary medical education” [22]. Corollary to this, The Royal College of Radiologist (RCR UK) pointed out why clinical radiology needs to be taught: (1) Clinical radiology is now integral to clinical management and understanding of imaging is fundamental to ensuring appropriate medical practice, and (2) medical images offer powerful tools for supporting learning in human morphology and physiology and understanding the nature of disease and response to treatment. All these support the need to revisit the vital role of radiology in the medical curriculum, and efforts must be made to ensure its indispensable position in the training of future medical practitioners. Radiology should no longer be an elective part of the curriculum now that so much of the study and practice of medicine depends on familiarity with imaging studies [23].

#### 3.2. Case in point

##### 3.2.1. Australia: challenges in implementation and sustainability:

The new curriculum in medical imaging has been hailed as a welcome addition to the medical program and largely well accepted by the students and general faculty alike. However, there are significant challenges to the long-term sustainability of this curriculum, largely because of a lack of staff dedicated to the teaching of radiology. As in many universities, our program relies heavily on clinical teaching delivered by staffs who are employed by hospitals, not by the university. The university lacks the resources to employ a large number of teaching staff across many hospitals and other healthcare environments. This model has served our university well for more than a century, but is showing increasing signs of strain as medical practice, particularly in traditional teaching hospitals, has become much more intense, stressful and time consuming.

Nowhere is this more evident than in radiology, which was once a rather relaxed practice environment with minimal after-hours commitments, a manageable day-to-day workload and a collegial and collaborative mindset. Today’s radiology department is increasingly a 24/7/365 business with high volume, fast turnaround, rapidly increasing workloads, inadequate staffing, and a sense of being under pressure and under competitive threat from other disciplines. Having argued for decades that medical imaging was crucial to patient care and developing and promoting an ever-expanding range of imaging technologies and applications, we have become victims of our own success.

This fundamental shift in radiology practice has led to frustrations in delivery of medical imaging teaching. Although there is enthusiasm for the recent curricular recognition of radiology in the medical program, the increased expectations this entails mean that there are difficulties recruiting new teachers and expanding
the range of teaching in many centres. The University can recognize such teachers through honorary teaching appointments, but this is a two-edged sword. For example, leading senior clinicians with weak research profiles may not be offered higher academic titles, leading to bad will. In most cases radiologists are swamped by their increasing clinical workload and largely lack the time and recognition that such teaching requires.

It is also recognized that some types of teaching are highly resource intensive, logistically challenging and are extremely unlikely to be replicated across all of our centres. A full day hands-on ultrasound teaching course is an example; this has to be delivered after-hours in a hospital setting with multiple machines and support staff, with patients or volunteers or paid models. Staff must be paid overtime rates, only a limited number of students can be accommodated and funding to support this activity is very limited. As a result, such teaching is recognized as exemplary, but cannot be delivered consistently to all students.

The new emphasis on curriculum, coordinated teaching and assessment has raised expectations for better quality teaching and improved standards. Today, most teaching in radiology is still conducted by clinical practitioners that have no formal expertise or training in teaching, who do not fully understand the curricular requirements and who are in many cases not recognized formally by the University.

3.3. What to teach?

A good foundation and understanding of radiology is essential in all practice areas of clinical medicine, will result in better and more efficient patient care and will minimize unnecessary tests, reducing the potential harm to patients and the depletion of resources [21]. Time and again, radiology has undergone an astounding revolution, which has profoundly affected not only the practice of the specialty, but that of medicine itself: the ability to produce computers powerful enough to reconstruct accurate body images, yet small enough to fit comfortably in the radiology department, has been the major key to this progress [24].

Diagnostic radiology face new trends, techniques, and advanced applications that need to be taught to medical students as it plays a role in their career as future clinicians. Advanced multimodality functional imaging such as PET/CT provides a good platform to teach anatomy and physiology as well as pathologic processes. Radiologic anatomy has gained grounds in context of the medical curriculum. Multiplanar imaging, “virtual endoscopy”, functional and molecular imaging and spectroscopy offer new ways to use imaging for teaching basic sciences to medical student [9]. Compared with the traditional curriculum, basic radiology as well as other imaging techniques to include ultrasound, computed tomography, magnetic resonance imaging, radionuclide imaging including PET/CT and angiography is seen to be integrated across medical specialties the medical curriculum of today, maximizing understanding of its use in the context of clinical practice. Shaffer et al. in their study integrating radiology education with core third-year discipline across a year long curriculum showed that this approach is feasible and the program may give students a better appreciation of the role of radiology in an ambulatory setting and in relationship to other specialties [25]. The early exposure of students in radiology during the first-year medical school training likewise improves their impression of radiology as a specialty and increases their interest in radiology as a career [26]. However, the challenge remains on (1) what aspects of and (2) how much of radiology education are essential to be integrated in the overcrowded medical curriculum in order to demonstrate an impact in the cognitive and clinical decision skills of the medical student. A strong interface between the medical student and the clinicians must always be integrated in the learning process in order to convey the essential and practical use of the different aspects of radiology essential to the student’s career as a future clinician.

3.4. Who should teach?

Radiology by radiologists. Perhaps this is the best practical and efficient way on who is the best person to be involved to teach the specialty. However, radiologist as not only confined nowadays to teach radiology alone, but in the light of integrated curriculum, there is an expanding role of the radiologist in the spectrum of the medical curriculum. Radiographic anatomy as well as the newer concepts of cross-sectional imaging is being taught by the academic radiologist. The Royal College of Radiologists pointed out that “Radiologists should be involved at all stages, from basic science to clinical practice. The learning experience of the role of clinical radiology is likely to be enriched by positive involvement by radiologists. Integration of radiology teaching into the clinical curriculum offers collaborative opportunities between radiologists and clinicians motivated to teach on imaging in their own clinical practice” [27]. We see the expanding role and involvement of the radiologist within the ranks of the academe, as well as their interaction with the medical students. Current studies likewise show the role of the radiologist will probably increase in future, teaching anatomy [7]. Not only are they confined to the classical reading of plates in basic radiology courses, but there is the increasing involvement of the specialist in cross-sectional anatomy, taught by the experienced radiologist within the academic rank. However, certain issues need to be addressed. Gunderman pointed that “With clinical payments for radiologic services falling, academic radiologists are under increasing pressure to augment their clinical productivity, making time for teaching an ever scarcer commodity. When every hour an academic radiologist devotes to medical student teaching represents an hour of lost clinical productivity, some departments are seeking ways to reduce their teaching commitments, reallocating faculty members’ time to non-educational activities that generate revenue”. Such are one of the limitations dictated by policy makers and the society preventing the radiologist to be actively involved in teaching medical students, and these issues needs to be addressed and resolved to encourage more radiologist to be involved in the academe and protecting their turf.

3.5. Case in point

3.5.1. Australia: the new medical imaging curriculum

In 2007, the Sydney Medical School undertook a comprehensive 10-year review of the Graduate Medical Program; three significant weaknesses were exposed. Senior clinicians identified that graduates were weak in anatomical knowledge, and recent graduates highlighted deficiencies in two key clinical fields: clinical pharmacology and radiology. As a result anatomy, clinical pharmacology and radiology were targeted for improvement. The discipline of medical imaging (with representation from radiology, nuclear medicine, physics, pathology and anatomy) and a new Chair of diagnostic radiology were created to address this weakness. Radiology and nuclear medicine began, for the first time, to actively teach as an integral part of the anatomy course.

As part of this change, a new vertically integrated curriculum in medical imaging was developed and launched in January 2010. This new curriculum is integrated with anatomy in the first 2 years to Medicine, Surgery, Paediatrics and other disciplines in the clinical environments. It emphasizes patient safety, appropriateness in selecting medical imaging investigations and the role of medical imaging in clinical practice. Imaging interpretation is included but is only emphasized for a limited range of key conditions, with
the goal of specifically teaching nuances of interpretation for these conditions only.

These changes have major challenges in implementation. Until recently, students in the Sydney Medical Program were taught Radiology on an *ad hoc* basis, with no central planning, coordination or curricular objectives. Learning resources were scattered across clinical schools, no core materials were available for distribution or use by clinical teachers, and radiology as a discipline was not involved formally in assessment. Students at rural and remote locations were in the main excluded from any direct radiology teaching, and lacked access to sites where they could observe medical imaging with a supervising radiologist.

This situation is slowly improving with newfound recognition of the importance of medical imaging for the modern medical practitioner. These fundamental changes include:

- Cross-sectional anatomy and introductory ultrasound is now taught by radiologists in collaboration with anatomists;
- New digital teaching resources in anatomy using medical imaging have been developed through this partnership;
- Core curriculum lectures in radiology are now recorded and delivered through streaming media;
- Radiology questions are now explicitly included in assessments, including OSCER and MCQs;
- Plans to collate, coordinate and pool medical imaging teaching across all clinical schools are being developed;
- Online and other digital learning resources are being selected and recommended, with resource-rich websites that promote appropriate use of diagnostic imaging and that provide evidence based information for patients and medical practitioners identified and recommended to students;
- Some teaching hospitals provide integrated clinical attachments whereby a small number of students spend 1–2 weeks in an imaging department;
- A small number of private radiology practices have to allow students to rotate through for observation and learning;
- Hands-on clinical ultrasound teaching has been introduced to late phase students in some centres.

4. Radiology and the digital age

James Thrall said that “For more than 25 years the vision of the all-digital radiology department has been a beacon guiding radiologists, computer scientists, and industrial developers in creating the equipment and the standards necessary to achieve this goal” [28]. With this recent evolution, coupled with the advances in educational technology, radiology has never been more vividly taught in medical school than today and is one of the greatest impacts in radiology education in medical schools. With the advent of new media and the compatibility of radiographic digital images in this technology, there is an even more increased enhancement in the interaction between medical students and radiology instructors in the learning environment.

The teaching of radiology has relied heavily on the value of images and plates taken, no matter the modality involved. With the digitalization of the radiographic images, these images are easily captured and made available not only in the clinical setting, but as well as in medical libraries as part of teaching files readily accessible to students. The advent of the picture archiving and communication system (PACS) allows transfer of diagnostic images to multiple sites, not only for clinical but also for educational purposes [29]. This innovative and creative use of technology will be essential in the current and future medical educational environment when time is short and faculty are in short supply [8]. The process enables more active and engaging activities between the teacher and students, as images can be simultaneously accessed and active discussion on the topic made.

Technological advancements in radiology go hand in hand with the digital age, and this is complementary to enhancing the overall learning environment. Various educational approaches such as Blended learning, which “combines multiple delivery media that are designed to complement each other and promote learning and application-learned behavior” [30], can be applied for teaching radiologic anatomy which optimizes the use of faculty, conforms to accepted theories of learning and are well accepted by students [8]. Other innovative teaching methods, not exclusive to radiology, can include use of videos, which can be uploaded by the teacher to be accessed by the students during self-directed learning activities (i.e., podcasts, youtube videos, etc.). Edutainment or higher-education content and entertainment, is being implemented in various medical schools and like in other academic settings, “professors are now combining the two, using various videos that contain both educational and entertainment value in podcasts and posting course content on education channels to create a more engaging learning environment” [31]. Thus are the different innovations in knowledge mobilization observed in the undergraduate radiology curriculum.

4.1. Case in point

4.1.1. Bosnia and Herzegovina

For the countries like Bosnia and Herzegovina possibility of joining the European Union in relatively close future would mean a fundamental reassessment of beliefs, attitudes, values, and structures developed during 50 years of communist regimes [32]. In this after war period Medical schools in Bosnia and Herzegovina will need to restructure medical curriculums within the unified Europe. Medical students in Bosnia, like in other post-communist countries have general positive attitudes towards science despite rather poor knowledge of research methods and scientific communication [33].

In universities in Bosnia 6-year medical school curriculum is divided into independent courses and in our medical school radiology is in the third year. Our graduates should know enough about radiology that they can use it usefully and assess radiological reports at their proper value. Recently, our learning process has moved from a teacher directed model to a more learner-centred model. We believe that ultimate goal of education is not for educators to teach well, but for learners to learn well [33]. In addition, we should help students become active, independent learners and problem-solvers [33]. From traditional learning theories we move to constructivist theory of instruction. From a constructivist point of view, the curriculum should consist primarily of working on the sorts of problems that learners are likely to encounter once they leave the instructional context [32]. Because of that attitude half of the curriculum time is spent on traditional lectures and half on radiological PACS based case studies in interactive teaching sessions.

Unlike other departments in developing countries, the Department of Radiology of the Clinical Center Banja Luka, is equipped with modern picture archiving and communication systems (PACS). PACS allow transfer of diagnostic images to multiple sites, not only for clinical but also for educational purposes. Our imaging database, established with software developed from PACS, has more than 400 cases suitable for undergraduate radiological education. An additional benefit gained from PACS is that students at an early stage become familiar with technology they will need to use in their future professional lives as well as with a new concept of learning community. A learning community may be defined as a group of people who share a concern, a set of problems, or a passion about a topic, and who deepen their understanding of this area by interacting on an ongoing basis [32].

Case-based learning is thought to be motivational to learners and it can provide scenarios from which complex concepts can be more easily understood. Case-based teaching was first applied
case-based instruction in radiology, in which third-year medical students are actively engaged in the integration of clinical and imaging information, can affect students’ views on the role of radiologists and their clinical management of patients. Furthermore, we believe that diagnostic imaging can be used to support the learning of anatomy and other basic sciences in the undergraduate medical curriculum.

5. Conclusion

Undergraduate radiology education has undergone modifications the past years, mostly as a response to curriculum changes. These changes in the medical curriculum are necessary as it reflects a response to address the contextual needs of the society. Radiology cannot be independent of the changes, as recent developments intensified its role in patient care. In the time of the traditional medical curricula, radiology is taught in the latter years, whereas presently we see a more integrated approach wherein radiology, in line with technological advances in its delivery, is taught in the formative years and carried throughout the curriculum, validating the important role radiology plays with the other specialties. Radiology is essential to patient management as is the radiologist integral to the teaching of this profession.

Conflict of interest

We have no conflict of interest.

References

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Fig. 1. Typical case-based radiology in the classroom. 54-year old male patient with discomfort and cramping in the left leg for angio CT of the lower legs. The students are presented with a case and corresponding high-resolution images are delivered in the classroom for discussion. Instructors lead the students through a series of interactive sessions to discuss the cases.

Fig. 2. Virtual dissection of the first image shows inguinal hernia that passed into the scrotum. Note the intestinal content of the hernia. Students are encouraged to be actively engaged in this process incorporating visual cues and cognitive learning.


