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Radiology In Medical Education: Active Methodologies And Contributions To The Diagnosis Of Acute Inflammatory Abdomen

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Abstract:
Background*: The teaching of Radiology in medical education presents significant gaps, especially regarding the request and proper interpretation of imaging exams.*
Materials and Methods*: This study conducted an integrative literature review, with searches in PubMed and SciELO databases, in order to identify weaknesses and strategies for improving Radiology education, with emphasis on the diagnosis of acute inflammatory abdomen.*
Results*: The results show that most students and early-career physicians report insecurity in using Radiology as a diagnostic tool, a consequence of teaching methodologies often dissociated from clinical practice. Studies indicate that the use of active methodologies, such as Problem-Based Learning (PBL) and Team-Based Learning (TBL), promotes greater knowledge retention and integration with medical practice. In addition, strategies such as the early introduction of the discipline, a multidisciplinary approach, the availability of integrated and digital teaching materials, and the encouragement of clinical reasoning have proven effective for the training of more confident professionals.*
Conclusion: *It is concluded that Radiology, when applied through active methodologies, is an essential tool for diagnostic qualification, especially in urgent contexts, such as the management of acute inflammatory abdomen.*
Key Word: *Radiology. Medical education. Active methodologies. Acute inflammatory abdomen.*

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I. Introduction

According to Wagner and Martins Filho[1], medical education in Brazil has undergone significant transformations in its curricula and teaching methods. In 2001, for example, the first National Curriculum Guidelines (DCN) for the medicine program were established. However, given the need to adapt medical training to the profile of the professional required by Brazilian public health, in 2014 these guidelines were updated. Among the main changes, the importance of creating and/or incorporating methodologies that encourage the active participation of students in the construction of knowledge stands out[1].

Thus, the teaching of Radiology for future physicians faces a significant challenge: students' insecurity when requesting and interpreting exams. This gap arises largely from teaching that is often disconnected from

clinical reality. Although there is no consensus in the literature regarding the need for increased class hours or the mandatory presence of specialists, research highlights the importance of radiology education that provides students with confidence[2].

In this regard, Brito, Souza, and Silva[3] emphasize that, in 2017, the National Supplementary Health Agency (ANS) revealed that Brazilian physicians requested more imaging exams in a single year than the average in developed nations such as the United States and Canada. That year, according to ANS data, the rate was 298 computed tomography (CT) scans and magnetic resonance imaging (MRI) exams per thousand beneficiaries, more than double the average observed in developed countries in the same period[3]. This, in turn, demonstrates that although physical examination remains a fundamental pillar of any medical consultation, imaging exams have become routine in both clinical and surgical practice[3].

According to Brito, Souza, and Silva[3], these exams play a crucial role in decision-making and in determining the most appropriate course of action for physicians, especially in medium- and high-complexity healthcare settings, such as Emergency Care Units (UPA) and Emergency Rooms, where rapid diagnoses are often required and imaging results are frequently interpreted by the on-duty physician without a radiologist's report[3]. Therefore, such routine, experienced by doctors from different specialties, underscores the importance of training professionals with the knowledge and skills necessary to fully benefit from these diagnostic technologies[1].

These approaches not only improve understanding but also enable professionals to employ Radiology more effectively in the diagnostic process, which is critical in situations such as managing acute abdomen. In all previously mentioned conditions, Radiology serves as a fundamental diagnostic tool for achieving positive health outcomes; thus, it is necessary to adequately prepare future physicians to understand the applicability of this tool, especially regarding acute abdomen.

Therefore, it is essential that health-related curricula focus on improving the academic and curricular training of the discipline of Radiology and Diagnostic Imaging, since, as pointed out by Silva et al.[4], it is fundamental in the context of medical practice, the training of future physicians, and in preventing the indiscriminate and incorrect use of complementary exam requests in the future.

However, for an active teaching methodology to be considered a good teaching strategy, Roman et al.[5] emphasize that it must meet certain requirements, such as: being collaborative; fostering group knowledge construction; providing activities integrated with other disciplines; allowing for the understanding and applicability of such knowledge in real contexts; being reflective, to strengthen principles of ethics and moral values; and critical, to stimulate students.

Thus, it is important to investigate what the specialized literature has gathered regarding these knowledge gaps in Radiology studies, considering that student protagonism in learning can be fostered, as Borges et al.[2] affirm, through a set of deductive reasoning methods that allow students, from concise material, to learn how to learn.

In this context, a proposal emerged within the Professional Master's Program in Health Education – Medical Education (ESEM), aiming to identify, through an integrative literature review, the main deficiencies in Radiology teaching, as well as to bring students closer to the subject and foster learning by providing a guide listing some diseases associated with acute inflammatory abdomen and a mobile application still under development.

II. Material And Methods

According to Gil[6], the Integrative Literature Review (ILR) is a research methodology aimed at synthesizing results from previous studies on a specific topic, regardless of the methodological approaches used (qualitative, quantitative, or mixed). That said, the present study, with the purpose of synthesizing existing knowledge on the subject, employed this method since it allows for a broad and in-depth analysis of the knowledge already produced, identifying gaps, divergences, and evidence that may support clinical practice or new research[6].

Approach

It is reported that the approach is qualitative, as it is a scientific research method focused on understanding and interpreting the depth and complexity of phenomena, behaviors, opinions, and human motivations[6].

Sample Selection

For the Integrative Literature Review, which is dedicated to studies on acute inflammatory abdomen, the main references from the established literature were consulted. Following this, free electronic searches were conducted, as shown in Table 1 below, in: a) PubMed; and b) the SciELO library, using the Boolean markers: Radiologia and aprendizado, and medicina and metodologia ativa.

III. Result And Discussion

Listed below are the articles used in the Integrative Literature Review.

Table 1 – Articles selected for the Integrative Literature Review (continued)

	Title	Result	Database	Year
1	Bridging the divide between medical school and clinical practice: identification of six key learning outcomes for an undergraduate preparatory course in radiology	Demonstrated that undergraduate medical training does not adequately prepare newly qualified doctors for their internship year.	PubMed	2021
2	Changes in postgraduate medical education in clinical radiology	Not described in the study.	PubMed	2008
3	Informatics in radiology: what can you see in a single glance and how might this guide visual search in medical images?	Found that trained radiologists can perform analogous tasks with medical images.	PubMed	2013
4	Current perspectives in medical image perception	With better understanding, ways can be developed to further improve decision-making and, consequently, patient care.	PubMed	2010
5	Evidence-based medicine: answering questions of diagnosis	This study illustrated how to formulate a question, search the literature, and then evaluate and apply the evidence.	PubMed	2004
6	Teaching radiology to junior doctors: their expectations, preferences, and suggestions for improvement	Most junior doctors felt that their radiology teaching in medical school had been inadequate.	PubMed	2011
7	Towards case-based medical learning in radiological decision-making using content-based image retrieval	By describing a case and a planned assessment framework, they were able to comprehensively evaluate the system.	PubMed	2011
8	Singapore National Medical Image Resource Centre (SN. MIRC): a world wide web resource for radiology education	The study revealed that Radiology education relies heavily on visual images, and case-based teaching files containing medical images can be an important tool for diagnostic radiology education.	PubMed	2006
9	A new approach to learning to teach: medical students as instructional designers	The experience of creating the files served as a hands-on learning opportunity for the student authors, both regarding the material and the teaching practice.	PubMed	2011
10	Innovative "Case-Based Integrated Teaching" in an undergraduate medical curriculum: development and teachers' and students' responses	Most respondents agreed that C-BIT is patient-centered and can be used to improve curriculum integration, reduce duplication in teaching, and enhance communication among faculty members from various disciplines.	PubMed	2008
11	Educational treasures in Radiology: The Radiology Olympics - striving for gold in Radiology education	The authors observed that the Radiology Olympics offer an international collaborative platform to educate medical professionals through an educational competition.	PubMed	2010
12	The development and evaluation of a medical imaging training immersive environment	Students reported high levels of satisfaction and perceived value, and the software enabled up to 40 simultaneous users to prepare for clinical practice.	PubMed	2014
13	Radiologists' preferences for just-in-time learning	Respondents expressed a preference for learning interventions lasting 5 to 10 minutes.	PubMed	2006
14	Electronic teaching files and continuing professional development in radiology	With appropriate tools and mechanisms exploring digital images, PACS, and the World Wide Web, radiologists will be able to use CPD to improve the quality of medical care.	PubMed	2008
15	Radiological anatomy - evaluation of integrative education in radiology	According to student suggestions, the course was improved by a visit to the Radiology Department and the addition of the central nervous system topic.	PubMed	2006
16	Strategic improvements for gross anatomy web-based teaching	Many students reported that using the web portal was essential for better understanding the relationships of anatomical structures.	PubMed	2012
17	Letter to the editor: The electronic learning habits of radiology trainees in London and South East England.	76% of respondents believed that easier access to electronic journals encouraged online learning. Seventy-six also stated that less restrictive IT policies at their institution would encourage the use of online resources.	PubMed	2011
18	Assessment of medical students' knowledge retention in a diagnostic radiology course: lecture attendees versus absentees.	The average lecture attendance rate was 76.8%, with the lowest at 56.8%. For unit tests, the mean score of Group A students (80.7 ± 7.3) was significantly higher than that of Group B	PubMed	2009

		students (76.2 ± 8.8) (P = 0.001).		
19	The learning curve of resident physicians using emergency ultrasonography for cholelithiasis and cholecystitis	Analyzing EUS test characteristics, for every 10 additional exams up to 50, there was no significant improvement in sensitivity or specificity for any of these ultrasound findings.	PubMed	2010
20	Limitations of student evaluations of curriculum	Encouragement for reading and interest in the field of radiology had mean scores for overall learning perception between 2.09–2.44, and mean scores for course continuation recommendation between 1.68–2.46	PubMed	1999
21	Evaluation of community based education and service courses for undergraduate radiography students at Makeree University, Uganda	In total, 71.4% of students participated in X-ray services and 39.2% in ultrasound services during COBES; 68.6% of students reported the need to be better prepared for COBES training.	PubMed	2008
22	A digital library of radiology images.	The search interface provides a user-friendly tool for accessing a large set of images and associated texts.	PubMed	2006
23	Integrative review of innovative tools for teaching-learning in anatomy in medical education	Of the 23 selected articles, six addressed the use of three-dimensional models; seven focused on radiological images; five referred to dissection; six covered simulators, games, and computerized environments; and two explored other methodologies, with some articles addressing more than one approach.	Scielo	2022

What Research Says About the Teaching of Radiology in Medical Schools

Traditional Method VS Active Method

Feitosa et al.[7] conducted a comparative study between active and traditional methodologies in Radiology teaching. Students in the early semesters identified Problem-Based Learning (PBL) and Team-Based Learning (TBL) as good strategies, significantly more so than students in later semesters (51%). In contrast, more advanced students considered lectures to be the most effective (78.2%). One of the justifications pointed out is that students in later semesters showed fatigue toward the idea of repetition[7].

Active methodology also proved superior in the study by Chan[8], conducted with 146 fourth-year medical students enrolled in the diagnostic Radiology course. The researcher administered a test after traditional lectures and another after two PBL sessions. These were individual tests applied immediately after the intervention, and a follow-up test was repeated four months later to assess retention. The average score of Group A (PBL) students was 80.7, significantly higher than Group B (traditional method), which was 76.2. There was no significant difference between the groups regarding knowledge retention[8].

How Much Time is Dedicated to Radiology Teaching in Undergraduate Programs and Who Provides This Teaching?

The study by Nyhsen, Lawson, and Higginson[9], conducted at Sunderland Royal Hospital in the UK, revealed in the free-text section of a questionnaire that the main request from students was "More guidance from radiologists."

Feitosa et al.[7], in their quantitative research, observed the difficulty of studying neuroradiology. The study involved 181 medical students in the second and seventh semesters of a university in Fortaleza, Brazil, using a 12-question survey with yes/no responses.

From the students' perspective, the main problem identified is that although students recognize their own role in learning, they overestimate the teacher's role and thus struggle to understand the teacher as a facilitator. This conclusion is supported by survey results, where most students reported difficulty in learning due to the fact that most professors treat images merely as teaching tools rather than guiding them on Radiology's role as a complementary diagnostic tool[4].

Main Difficulties in Teaching Reported by Students

After briefly characterizing Radiology teaching, it is important to describe the findings concerning the major difficulties reported by students in this literature review. The goal is to improve teaching by addressing these weaknesses. One of the greatest challenges listed by students was the need for prior basic Radiology knowledge and recognition of their limited ability to retain content and integrate it with clinical practice[7].

In addition, research highlights as difficulties the gap between what is taught during medical school and what is actually needed in medical practice. A study comparing the views of medical interns and Radiology faculty revealed that both groups perceived a problem: the subjective sense that undergraduate training does not prepare interns to engage with the Radiology department[10].

Weaknesses in Ordering and Interpreting Imaging Exams

A study with medical interns and residents found that most respondents (66%) felt that undergraduate training did not prepare them to discuss cases with radiologists, particularly regarding image interpretation and subsequent clinical decisions. Of these students, 76% reported difficulty analyzing exam results, and 26% did not feel confident explaining the results to patients[7].

In this study, most interns expressed difficulty and/or uncertainty in ordering imaging exams for clinical investigation. Most radiologist preceptors (92%) agreed with this deficiency. Comparative studies also reported a lack of understanding regarding the appropriate use of different imaging modalities[7].

Main Suggestions for Improvement Found in the Literature

Early Introduction of the Discipline

The early inclusion of Radiology in the first semesters of medical school has a positive effect. According to the authors, students suggested that Radiology could help in understanding pathophysiology and morphofunctional changes[7]. In this sense, respondents considered that it could assist in introducing important clinical concepts in the early years, establishing a connection with medical practice.

Similarly, at Hannover Medical School (MHH), the early introduction of Radiology increased student awareness of the field and had positive effects, with students being more likely to continue in this specialty. This is particularly relevant given the current difficulties in attracting students to Radiology[11].

Multidisciplinary Radiology Teaching with Clinical Correlation

In their study, Nyhsen, Lawson, and Higginson[9] found that students clearly preferred interactive, case-based discussions as their favorite teaching method, followed by system-based interactive discussions. Likewise, at an institution in the United Arab Emirates, students perceived diagnostic Radiology within an integrated curriculum as satisfactory and beneficial[12].

Thus, the importance of interdisciplinarity becomes evident—linking the morphofunctional curriculum component, tutoring, and clinical skills with Radiology[4]. In a study conducted in Uganda, East Africa, with 35 participants (students, graduates, professors, and tutors), using a Likert-type questionnaire and recorded interview analysis, more than 85% of participants considered the integration of Radiology into community health units (i.e., in practical and multidisciplinary contexts) to be an excellent strategy to avoid the pitfalls of teaching disconnected from clinical reality[4].

Development of Image Interpretation Skills

The rapid assessment of medical images by radiologists raises the question of the importance of global image perception in Radiology knowledge. One study demonstrated that diagnostic accuracy among radiologists is above chance when exposed to a chest X-ray for only one-fifth of a second (less than the time required for a single voluntary eye movement). It was observed that orientation by basic features (such as color) does not require learning, but evaluation of complex properties does[13].

Understanding the role of image processing may help distinguish novice from expert radiologists and support the creation of new medical training methods based on image perception. The author describes that searching for abnormalities or specific objects is usually performed through a deliberate process of sequential analysis[13].

Individualized Supporting Material

Regarding study materials, several articles highlight the importance of personalized teaching resources. In the study by Silva et al.[4], students pointed out that the recommended bibliography either fails to integrate Radiology adequately or is too specific, with Radiology isolated from clinical reasoning. One respondent emphasized: “When we see everything together, it makes it easier to understand the subject—it’s a pity we don’t have integrated material to study [sic].”

Availability of Electronic and Editable Materials

Research also shows that younger physicians prefer online resources and short case review books, while Radiology textbooks, review articles, and original research are rarely used by them, as they prefer concise and practical information[9].

Other studies indicate that most Radiology teaching interventions are delivered electronically. For example, at the David Geffen School of Medicine, several student volunteers participated in projects to create digital teaching files, most developed using Adobe Flash. Although previous Radiology files highlighted important structures, they lacked clinical context. Thus, the new digital manuals presented dozens of classic findings of common diseases, differential diagnoses, and clinical correlations to guide exam requests and interpretation[14].

The authors emphasized that the creative freedom and autonomy given to students were essential to the project's success. While there was an established digital file structure, this did not prevent other schools from developing similar projects using different media with similar success[14]. This shift toward online methods predates 2011, with reports as early as 2004 describing the use of image archiving and communication systems—74% in private facilities vs. 59% in public hospitals. Meanwhile, in the US, the most common Radiology teaching approach relied on computer interaction or digital image archiving systems[12].

IV. Conclusion

According to the reviewed literature, it was possible to identify that the main weaknesses in Radiology teaching consist of a shared feeling of technical incapacity in both ordering exams and correctly interpreting them. Several studies mention students' insecurity in the field of Radiology, whether as residents, medical students in primary care units, or even in emergency services when newly graduated especially due to teaching that is dissociated from clinical practice. In this context, Radiology teaching associated with a more comprehensive understanding of the patient has shown greater acceptance among students.

The findings in the literature were not significant regarding the need for increased workload or the indispensability of specialists (Radiology professionals as facilitators of teaching). The same applies to alternative tools such as the use of games. On the other hand, there is strong evidence supporting the better effectiveness of Radiology teaching under the framework of active learning methodologies, as well as the fact that student interest is greater when they have access to concise teaching materials with clinical correlations that can support Radiology learning, particularly in aspects with high clinical applicability.

Based on the clinical importance and the reasons outlined in the justification that led to the present study, the main etiologies of acute inflammatory abdomen were identified in order to develop a product that combines a highly relevant topic (minimizing issues related to the vast scope of the discipline) with the best practices of Radiology teaching, according to the reviewed literature.

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