Original Publication

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Diagnostic Imaging Fundamentals: Brain Vascular Pathology

Erwin Xia*, Efrain Lee-Diaz, Miguel Trelles de Belaunde, MD, Jorge Lee Diaz, MD

*Corresponding author: erwinxia@gmail.com

Citation: Xia E, Lee-Diaz E, Trelles de Belaunde M, Lee Diaz J. Diagnostic imaging fundamentals: brain vascular pathology. *MedEdPORTAL*. 2017;13:10535.

https://doi.org/10.15766/mep_2374-8265.10535

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Abstract

Introduction: This module was created to supplement the traditional learning methods that senior medical students, first-year radiology residents, and residents in other specialties employ to learn the fundamentals of radiologic image interpretation. It is part of an ongoing project entitled Diagnostic Imaging Fundamentals (DIF), with each module covering a unique topic. This module covers brain vascular anatomy, common imaging modalities, and imaging characteristics of brain vascular pathologies. **Methods:** This module has been designed for team-based learning and consists of advance-preparation reading material, in-class individual and group readiness assurance tests, and a group application exercise. Students are evaluated both individually and as groups. These DIF modules are designed primarily for group learning and are well suited for the academic setting. **Results:** The feedback we received from first-year radiology residents was 100% positive, and the most frequent remark used by learners in their comments was “very helpful.” Our limited feedback suggests that the level of material is appropriate for trainees at or above their final year of medical school. **Discussion:** We are confident that this module will benefit students and residents who are eager to learn the fundamentals of brain vascular imaging and will serve as a useful adjunct to traditional methods of learning. We believe the module’s application of team-based learning can act as a model for collaborative learning in a traditionally didactic learning environment. Future work will include expanding use of the module to larger groups of radiology residents, medical students, and residents in other specialties.

Keywords

Team-Based Learning, Radiology, Neuroradiology, Brain Vascular Pathology

Appendices

- A. Diagnostic Imaging Fundamentals-Brain Vascular Pathology.pdf
- B. RAT Student Packet.docx
- C. RAT and Group Application Exercise Images.pptx
- D. IRAT Student Answer Sheet .docx
- E. GRAT Student Answer Sheet.docx
- F. RAT and Group Application Exercise Answers.pptx
- G. Group Application Exercise Student Packet.docx
- H. A-F Cards.docx

All appendices are peer reviewed as integral parts of the Original Publication.

Educational Objectives

By the end of this module, learners will be able to:

1. Recognize, identify, and describe the anatomy of major blood vessels in the brain.
2. Compare and contrast the different modalities used to image the brain.
3. Recognize, identify, and describe major brain vascular pathologies and their characteristic appearance on imaging.

Introduction

Ever since team-based learning (TBL) was introduced into medical education in 2001, increasing numbers of medical educators have implemented its student-centered, instructor-led format. TBL is an evidence-based collaborative learning strategy that thrives by using small-group interaction to improve students’ ability to apply course content.¹ In contrast to traditional teaching methods, where students are passive recipients of information, TBL places the responsibility of initial exposure to course content in the students’ hands. Rather than simply familiarizing students with concepts, TBL requires students to use those concepts to solve problems.²

Radiology has been a discipline where traditional learning methods have predominated. Most residency programs offer daily conferences, in which residents are given didactic lectures or are exposed to a variety of case presentations. Radiology residents are often expected to absorb a great deal of information

that they will later be asked to apply in the reading room. Though this traditional educational model has been effective, we believe TBL can serve as a valuable adjunct by allowing students to immediately apply what they have learned through exercises that require them to use their knowledge. TBL integrates knowledge acquisition with knowledge application and allows students to gain a much better sense of the relevance of the material in the real world.²

Given the success of a previous module entitled “Diagnostic Imaging Fundamentals: Head Trauma,”³ this module was created as a brief and straightforward guide to the interpretation of imaging studies of patients with brain vascular injury. This module exists as part of a series entitled Diagnostic Imaging Fundamentals and is targeted to first-year radiology residents, fourth-year medical students, and residents in fields such as emergency medicine, neurology, and neurosurgery. However, anyone with an interest in brain vascular imaging would benefit from its concise descriptions and numerous examples. By the conclusion of this module, learners will be able to recognize and describe major brain vascular injuries and create a differential diagnosis based on radiologic appearance.

We believe that the module’s design as a TBL exercise makes it an effective learning tool. Students progress beyond mere acquisition of facts and achieve a depth of understanding made possible through peer collaboration and application of knowledge to real-life scenarios. Students gain an appreciation for the relevance of brain vascular imaging in real-world situations and improve their ability to make decisions quickly and confidently by practicing in a low-risk setting.

This module may be implemented in a variety of educational settings: in place of traditional lectures, as part of a medical school curriculum, or informally for individuals who have an interest in neuroradiology. The team-based format places less of a burden on the instructor, who, rather than dispensing information, acts more to facilitate the educational process.

We believe the team-based approach also fosters an appreciation for the value of teamwork in solving challenging problems and facilitates camaraderie among peers. TBL has also been shown to enhance performance on examinations.⁴ We are confident that this tool will benefit residents and students at varying degrees of training and in multiple educational settings. The module is the result of collaborative effort from individuals at different institutions and has been written with reference to the existing literature, compilation of unique images, and participatory feedback from residents.

Methods

Team Formation

Students are divided into teams by the instructor at the beginning of the session.

Advance-Preparation Resources

Students are expected to read “Diagnostic Imaging Fundamentals: Brain Vascular Pathology” (Appendix A) in preparation for the TBL session. This text contains a brief overview of brain vascular anatomy, imaging modalities, and pathology that should enable students to successfully answer all TBL questions. The reading should be made available to students 1 week prior to the session and ought to take 3-4 hours to complete. Additional resources, though not required, are encouraged. A useful supplement is Yousem and Grossman’s *Neuroradiology: The Requisites*, chapter 4: “Vascular Diseases of the Brain.”⁵

Instructors should have access to a classroom with projection capability where students can take the individual readiness assurance test (IRAT) and the group readiness assurance test (GRAT), work in teams on application exercises, hear the instructor, and see the PowerPoint presentation. The instructor should be a content expert. Materials the instructor needs to have available include the following:

- Blank sign-in sheet.
- Readiness assurance test (RAT) student packet—one per student (Appendix B).
- PowerPoint with RAT and group application exercise images (Appendix C).
- IRAT answer sheet—one per student (Appendix D).
- GRAT answer sheet—one per group (Appendix E).
- Blank score sheet—to record students’ IRAT and GRAT grades.

- PowerPoint with RAT and group application exercise answers (Appendix F).
- Group application exercise—one per group (Appendix G).
- A-F cards—one set per group (Appendix H).

Readiness Assurance Questions

The RAT student packet (Appendix B) consists of five multiple-choice questions, which students are allotted 6-minutes to complete. Relevant images (Appendix C) are projected on a large screen. Students write their answers on the IRAT answer sheet (Appendix D), and the instructor collects these at the end of the 6 minutes. Following completion of all IRATs, students are divided into teams, where they discuss the answers to each question as a group and record their final answers on the GRAT answer sheet (Appendix E). Ten minutes are given for completion of this portion. The instructor then collects answer sheets from each group, reviews the correct answers to each question with the group using the PowerPoint presentation (Appendix F), and clarifies any questions. Students are given an opportunity to verbally appeal incorrect answers. No books or resources should be used during this portion of the TBL.

Immediate Feedback

Verbal feedback is given after the GRAT and the group application questions. The answers are also projected on a large screen, along with labeled images, using Appendix F.

Group Application Exercise

The group application exercise (Appendix G) consists of five cases (15 total questions) that help students apply their knowledge to lifelike scenarios. Each team is given several minutes (at the instructor's discretion) to reach a consensus answer to each question; then, when prompted to do so, all teams simultaneously reveal their answers to each other using A-F cards (Appendix H). The instructor asks each team to explain its reasoning and facilitates debate between the teams. After discussion, the facilitator reveals the best answer using the PowerPoint presentation (Appendix F) and points out the relevant imaging findings. Each case should take approximately 10-15 minutes. A timer may be used to assist with time management.

Facilitation Schema

Timing breakdown (approximately 1.5 hours):

- IRAT—6 minutes.
- GRAT—10 minutes.
- RAT review/discussion—10 minutes.
- Group application exercise—70 minutes.

Results

After implementing the TBL with a group of first-year radiology residents at the University of Texas Medical Branch, we received the following feedback:

- “Very helpful. Good alternative for classic lecture. Good topic focus.”
- “Very helpful, way better than regular lectures. ‘Twist ending’ cases (where the final diagnosis ends up being something you didn’t think of at first) are very helpful. Very nice! Thanks.”
- “Great lecture. Case-based makes it more interesting and interactive; would prefer more lectures in this style. Mix of topics is preferred over one single topic.”
- “I think it is very helpful because these are topics that we don’t see at the neuroradiology rotation. I like the interactive method because is a different method to learn besides reading. I like multiple topics because you cover more information.”

Although formal metrics were not obtained, we received an overwhelmingly positive response (100%) from learners. The qualitative data demonstrate that our module and the TBL format were well received. Because the residents had already completed their neuroradiology rotations by the time of the TBL, they were able to answer all RAT questions without difficulty. Performance on the group application exercise varied, ranging from 73% to 93% among groups. No questions or explanations were appealed. One resident remarked that the module would have been helpful before rotating in neuroradiology, as many of

the concepts were covered on the rotation. The module was also very well received by fourth-year medical students who were given a preview of the materials. They expressed eagerness to try the module, although a formal TBL session was not conducted. Our limited feedback suggests that the level of material is appropriate for trainees at or above their final year of medical school.

Discussion

Overall, our module was very well received by residents and students. It succeeded in serving as a brief overview of brain vascular imaging. We believe the module's utilization of TBL further enhanced its content. The module's design was largely based on a previous publication belonging to the same series.³ It was developed using actual clinical cases, images, and reference to the existing literature. The module is comprehensive enough to offer those with little to no experience in imaging sufficient background to successfully complete the TBL cases while being concise enough to offer those with experience a succinct review of important pathology. For those who desire to learn radiology outside of traditional classroom methods, our module presents the perfect opportunity.

Challenges encountered along the way include discerning the appropriate level of material to incorporate and producing a unique yet comprehensive overview that would prove useful to a wide target audience. Limitations include difficulty finding a sample group of residents available to test the module. This may represent a real challenge in an academic setting where clinical duties make it difficult to allocate time for outside-of-class preparation. Furthermore, the estimated 1.5 hours of in-class activity could also pose a challenge. We were able to complete our TBL in 1 hour, and there were no complaints regarding the time required for preclass preparation. Another limitation is the lack of objective data following our TBL. Based on qualitative feedback, however, we are confident that our module will be beneficial to students and residents who have limited experience in neuroradiology. Those with more experience may find the module a useful review.

Future work will include testing the module with medical students and residents in other specialties such as emergency medicine, neurology, or neurosurgery.

Lessons Learned

Through live implementation of our module, we gained valuable information that has been used to further refine the module for future use. We extended the period of time in which students have access to the required text, allowing more flexibility for preclass preparation. We also created a new file containing images for RAT and group application exercise questions designed to be projected on a large screen. We realized that the images would be difficult to appreciate fully on printed paper alone. Furthermore, we discovered that lengthy discussion of some questions occasionally resulted in shortened discussion of other questions. Since many of these questions were answered by later cases, we recommend the optional use of a timer to assist with time management and perhaps even designating some time at the end of the module for a question-and-answer session. We also found that giving students an opportunity to offer immediate feedback (both verbal and written) following completion of the module was valuable to the instructor and helped improve the module for future use.

Erwin Xia: Fourth-year Medical Student, University of Texas Medical Branch School of Medicine

Efrain Lee-Díaz: Second-year Medical Student, Universidad Peruana Cayetano Heredia

Miguel Trelles de Belaunde, MD: Chairman of Radiology, Clinica Delgado

Jorge Lee Díaz, MD: Neuroradiology Fellow, Johns Hopkins Medicine

Disclosures

None to report.

Funding/Support

None to report.

Ethical Approval

Reported as not applicable.

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Received: July 20, 2016 | **Accepted:** January 3, 2017 | **Published:** January 30, 2017