Article published online: 2023-09-04

The Impact of a Hands-On Interventional Radiology Training Course on Radiology Resident's Training: A Single Academic Institution Experience

Nicholas Guimbarda[1] Hashim Armashi[2] William Parker[2,3] Arthur Freedman[2,4] Islam A.S. Elhelf[2,4]

[1] Medical College of Georgia, Augusta University, Augusta, Georgia, United States
[2] Department of Radiology, Medical College of Georgia, Augusta University, Augusta, Georgia, United States
[3] Neuroradiology Section, Department of Radiology, Medical College of Georgia, Augusta University, Augusta, Georgia, United States
[4] Interventional Radiology Section, Department of Radiology, Medical College of Georgia, Augusta University, Augusta, Georgia, United States

Address for correspondence Islam Elhelf, MD, PhD, 1120 15th Street, BA 1411, Augusta, GA 30912, United States (e-mail: ielhelf@augusta.edu).

Arab J Intervent Radiol 2023;7:94–99.

Abstract

Purpose The aim of this study was to investigate the outcomes of an instructional hands-on training course that introduces radiology residents to the essential tools and skills needed to perform basic interventional radiology (IR) procedures.

Materials and Methods This study was performed over a single academic year at a single academic institution. A precourse survey was sent to all radiology residents to identify areas of weakness and potential opportunities for improvement. In view of the responses, a hands-on training course was designed to cover the basics of vascular and soft-tissue access, catheters, wires, embolics, and closure devices. The training was provided in a one-to-one setting by a single IR attending over a period of 45 minutes and was concluded with hands-on training on an ultrasound (US) vascular access phantom whenever possible. An anonymous postcourse survey was then distributed and the results were analyzed.

Results The average reported comfort level with basic IR concepts prior to course attendance was 1.7 on a 5-point scale (1 = not comfortable, 5 = very comfortable). This increased to an average of 4 following the course. Ninety-three percent of residents reported they have more confidence getting into the IR suite and assisting in IR procedures following the course. Residents who had an opportunity to train on the US vascular access phantom gave an average response of 4.6 out of 5 to a question of how helpful the experience was in improving their US hand skills (1 = not helpful, 5 = extremely helpful). One hundred percent of responders reported that the course successfully met its goal. Finally, the overall responses were unanimously in favor of continuing the hands-on training course.

Conclusion A personalized, cost-effective, hands-on training course can improve the IR training experience of radiology residents, especially in the early training phase. This model is of particular value for smaller to medium-sized academic institutions with limited financial and educational resources.

Keywords
- interventional radiology residents
- radiology training
- training course

article published online
September 4, 2023

DOI https://doi.org/10.1055/s-0043-1771331.
ISSN 2542-7075.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

Introduction

In 2014, the Accreditation Council for Graduate Medical Education (ACGME) approved the integrated interventional radiology (IR) residency. Since that time, a significant effort has been placed to structure a comprehensive IR training curriculum to ensure mastering of essential IR procedural skills with emphasis on clinical care delivery.[1] Diagnostic and integrated IR residents alike spend the majority of their first three residency years in a diagnostic radiology (DR) setting. At this level, a didactic lecture series is extremely important to build the fundamentals of DR practice.[2,3] However, residents are required to rotate in IR as well, an entirely different environment from the DR reading rooms. While integrated IR residents are usually excited to rotate in IR, DR residents may be overwhelmed by the different pace and training style in IR. Despite this, DR residents are expected to master basic IR skills to perform simple IR procedures as it is integral for the completeness of their overall training.[4,5] Another advantage of required IR rotations is to expose residents to the field of IR so they can make the appropriate decision on whether they wish to apply for an Early Specialization in Interventional Radiology (ESIR) position following their R3 year.[6]

The Society of Interventional Radiology (SIR) reviewed accredited radiology programs and investigated the design of their IR rotations, specifically the procedural components; they found vast heterogeneity among the training programs. As a result, a task force was created to standardize residency training by defining adequate IR training, regardless of the trainees' intended career. For residents planning to pursue a career in general radiology or DR, the goal was to ensure that residents gain procedural experience as the primary operator in basic image-guided procedures.[6] While medical simulation trainings through high-fidelity phantoms, and even cadaveric models, for various endovascular and image-guided percutaneous procedures are a hot topic in medical education literature, they are associated with financial and logistical constraints, which limit their broad adoption, especially in smaller academic institutions.[7] Larger academic institutions may have dedicated simulation centers for medical training; however, smaller size institutions do not have access to these high-cost resources and would benefit more from low-cost training courses, promoting equity in medical training among institutions.

For our residents to fulfill the procedural recommendations set forth by the SIR, and get the most out of their IR rotations, we designed a hands-on training course addressing the essential IR tools, concepts, and skills, geared specifically for residents early in training (R1–R3). In this article, we report our institutional experience on how this course was structured and delivered to the residents. We also discuss the impact of this course on residency training as conveyed through outcome analysis surveys. We will shed light on how this course can be adopted in small to medium-sized academic programs and share our insight into potential areas for improvement.

Material and Methods

Study Design

This study was conducted in a single academic institution over one academic year: July 2021 to June 2022. No institutional review board was required for this study. The study population consisted of all radiology residents ($n = 25$) in each level of training at our institution. An anonymous pretraining course survey (presurvey) was distributed to each resident to gain insight of our residents' overall attitudes and interest in IR, prior understanding of IR procedures, learning styles, previous IR rotations (if applicable), and if they believe a hands-on training course would be beneficial for their overall learning experience. Nineteen responses to the presurvey were collected and the feedback was largely in favor of the proposed training course. The results of this survey, along with suggestions from a free response text suggestion box, were used to design and define the learning objectives of the training course.

The training course was then delivered as detailed below. An anonymous posttraining course survey (postsurvey) assessing our residents' change in comfort level with procedures, overall course design, and other suggestions to improve the course was then distributed to each of the residents.

Training Course Construction

The course was designed to cover the basics of vascular and soft-tissue access, types, and uses of different catheters, microcatheters and guidewires, types and uses of embolic materials, as well different types of closure devices (►**Table 1**). Residents were allowed to hold the equipment and explore the components of different devices, for example, coaxial access systems and closure devices. Residents were also encouraged to ask questions, no matter how simplistic. Following explanation of the basic concepts, two simulated procedural scenarios were pursued, the first being a gastrointestinal bleed and the second being a tumor embolization. Each step of both procedures was discussed by the training attending, from vascular access to closure. The resident was expected to make use of the concepts discussed to dictate the appropriate "next step" and make suggestions on how to tackle simple challenges that may be encountered during these procedures. Instantaneous feedback by the training attending was provided and troubleshooting tips were shared.

The course was conducted over a duration of 45 minutes in a one-to-one setting by a single fellowship trained attending. This was followed by a hands-on training on an ultrasound vascular access phantom (Ultrasound Guided IV Trainer 3-vessel Phantom, Your Design Medical, New York City, NY, United States) for an additional 30 minutes (whenever time allowed; ►**Fig. 1**). Residents were given chance to have further discussions with the attending following conclusion of the course to answer questions and address concepts warranting further explanation.

Table 1 Concepts discussed and equipment used during the training course

Concept	Tools
Access:	
Vascular access	• Mini Stick Max (AngioDynamics, Navilyst Medical, Inc., Marlborough, MA, United States)
Soft-tissue access	• Chiba Needle (Cook Medical, Cook Inc., Bloomington, IN, United States) • AccuStick II (Boston Scientific, Natick, MA, United States)
Wires:	
0.035-inch wires	• Amplatz Super Stiff (Boston Scientific) • Bentson Wire Guide (Cook Medical, Cook Inc.) • HiWire Hydrophilic Wire Guide (Cook Medical, Cook Inc.)
0.018-inch wires	• Angled Glidewire GT (TERUMO, Terumo Corporation, Tokyo, Japan) • Double Angle Glidewire GT (TERUMO, Terumo Corporation) • V-18 Control Wire (Boston Scientific)
Catheters:	
Flush Catheters	• Omni Flush catheter (AngioDynamics, Inc., Queensbury, NY, United States) • Pigtail catheter (AngioDynamics, Inc.)
Selective base catheters:	• C2 Catheter (Cook Medical, Cook Inc.) • Sos Omni Selective 2 (AngioDynamics, Inc.) • Kumpe catheter (AngioDynamics, Inc.) • Angled Taper Glidecath (TERUMO, Terumo Corporation) • Mikaelsson Catheter (Merit Medical Systems, Inc., South Jordan, UT, United States)
Microcatheters	• Progreat Microcatheter System (TERUMO, Terumo Corporation)
Embolics:	
Gelfoam	• SURGIFOAM (Ethicon, Inc., Bridgewater, NJ, United States)
Coils	• Nester embolization coil (Cook Medical, Cook Inc.) • AZUR CX35 detachable coil (TERUMO, Terumo Medical Corporation, Somerset, NJ, United States) • AZUR CX18 detachable coil (TERUMO, Terumo Medical Corporation)
Particles	• Embosphere Microspheres (Merit Medical Systems, Inc.)
Closure devices	• MYNXGRIP vascular closure device (Cardinal Health, Santa Clara, CA, United States) • AngioSeal VIP (TERUMO, Terumo Medical Corporation)

Results

We collected 19 presurvey and 14 postsurvey responses. Responses were collected using the Google Forms software. For the presurvey, our sample showed homogenous participation from R1–R4 residents (5 R1s, 5 R2s, 4 R3s, and 5 R4s; ►**Fig. 2A**). Seventeen responders (89.5%) were males, 1 responder (5.3%) was a female, and 1 resident (5.3%) preferred not to say. Twelve residents (63.2%) were interested in IR to the extent that allows them to perform light procedures, 5 residents (26.3%) were highly interested in IR and likely to pursue an IR career, 1 resident (5.3%) was not decided about his interest level, and another 1 resident (5.3%) was not interested in IR (►**Fig. 2B**). When asked about their insight regarding the best educational platform to learn IR (residents were allowed to choose more than one answer), the majority of responses ($n = 18$, 94.7%) were in favor of receiving a hands-on training on the IR essentials before going into procedures, 11 responses (57.9%) chose going into IR procedures directly and learning by observation, while 8 responses (42.2%) chose didactic lectures (►**Fig. 2C**). Thirteen residents (68.4%) reported they did not receive dedicated hands-on training during their current training, while 6 residents (31.6%) reported that they have received such training. When asked to rate the extent they may think a hands-on training course can be helpful for their training on a scale of 1 to 5 (1 = not helpful, 5 = extremely helpful), 16 residents (84.2%) responded 5, and 3 residents (15.8%) responded 4 (►**Fig. 2D**). Fourteen residents (73.7%) reported that they would like to receive this training course in their first rotation and an additional refresher course on subsequent IR rotations, while 5 residents (26.4%) preferred to have the training only in their first IR rotation.

Regarding the postsurvey results, most of the responders ($n = 7$, 50%) were R1s, 4 residents (28.6%) were R2s, and 3 residents (21.4%) were R3s. Thirteen responding residents (92.9%) were males, and one resident (7.1%) was a female. All responders ($n = 14$, 100%) reported that the course was helpful for their IR training and met the goal of introducing them to the basic concepts of IR prior to doing cases. Prior to this course, the average reported comfort level with basic IR concepts was 1.7 on a scale of 1 to 5 (1 = not comfortable,

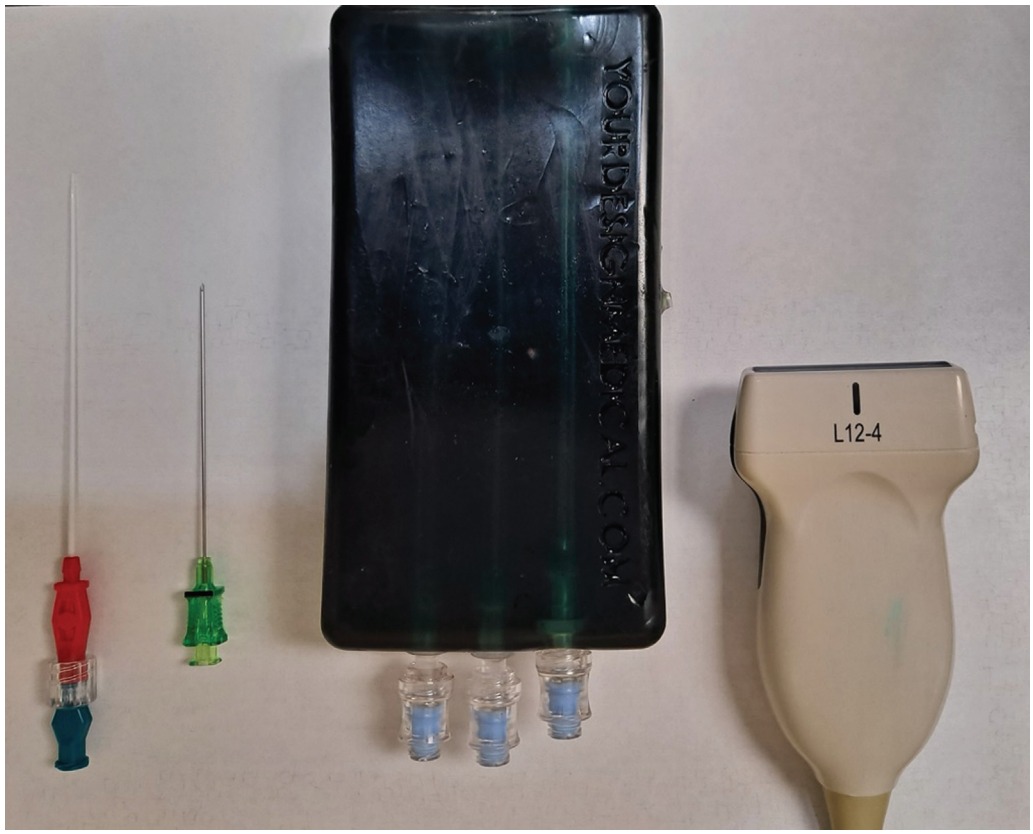

Fig. 1 The ultrasound phantom and equipment used to provide training on ultrasound-guided vascular access.

5 = very comfortable). This increased to an average response of 4 following the course (►**Fig. 3A**). Thirteen residents (92.9%) reported they have more confidence getting into the IR suite and assisting in IR procedures following the course, while one resident (7.2%) was unsure (►**Fig. 3B**). Only nine residents (64.3%) had the chance to train on the US vascular access phantom. Of these residents, seven residents (77.7%) reported a score of 4 to 5 on a 1 to 5 scale (1 = not helpful, 5 = extremely helpful), for the extent the US phantom improved their US skills. Two residents (22.2%) reported a score of 3 (►**Fig. 3C**). Finally, the overall responses were unanimously in favor of continuing the hands-on training

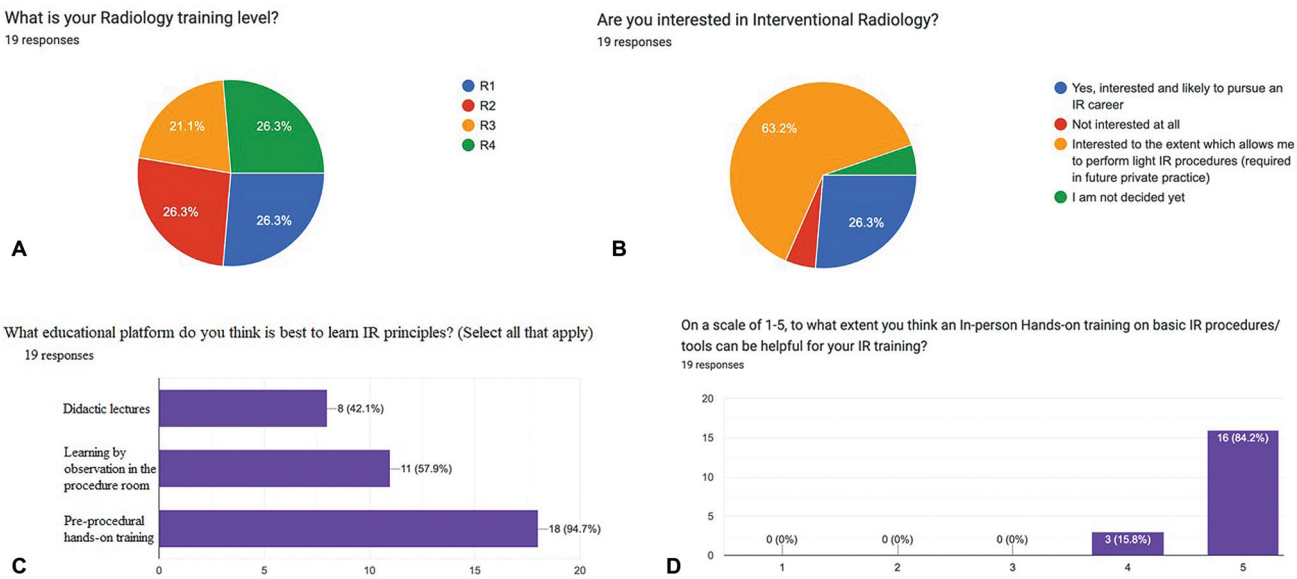

Fig. 2 Results of the pretraining course survey. (**A**) Radiology training level of participants showing homogenous participation of R1–R4 residents. (**B**) Participants' prior level of interest in interventional radiology (IR). (**C**) The preferred educational platforms to learn IR. (**D**) Perceived level of benefit an in-person hands-on training course would be for the participants.

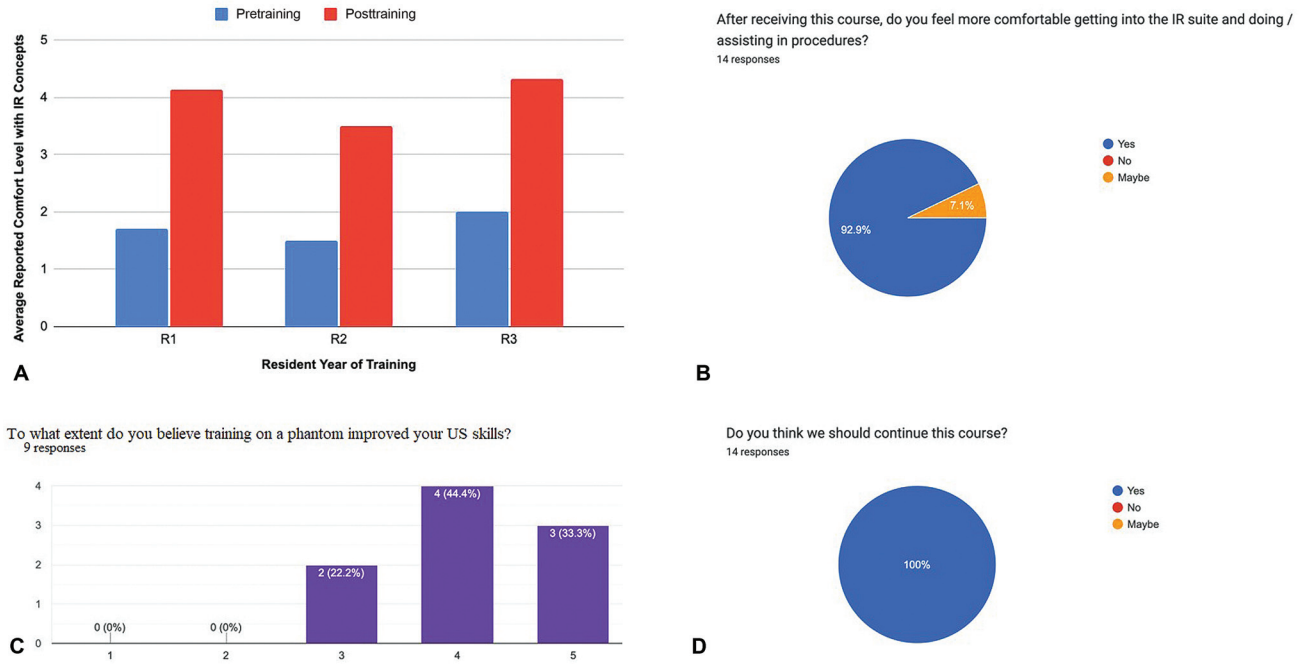

Fig. 3 Results of the posttraining course survey. (**A**) Average reported comfort level with basic interventional radiology (IR) concepts before and after the training course among R1–R3 participants. (**B**) Reported comfort level of performing/assisting in IR procedures. (**C**) Reported improvement of hand skills following training with ultrasound (US) phantom. (**D**) Reported resident responses to whether the course should be continued in subsequent years.

course (►**Fig. 3D**). Of note, many of our residents emphasized that the course should take place during their first year of residency.

Discussion

Residents' training, particularly in procedural based specialties like IR, can be challenging in many ways. Technology-enhanced simulations have proven to be an effective tool for hands-on training in this context; however, simulation technology is expensive and may be beyond the financial capabilities of smaller academic institutions.[7–9] In most academic institutions, the majority of IR training occurs in the angiography suite following the classic master–apprentice model.[8] While efficient, this model has some challenges particularly in the early training phase when trainees are stressed out and overwhelmed by the highly demanding IR environment. Our goal was to design a personalized, hands-on training course that would provide a relaxed learning experience for residents to learn about the basics of IR. The ideal training course, in our opinion, should be of low cost and can be easily adopted in other small to medium-sized academic institutions.

To achieve the "personalized" nature of this training course, a precourse survey was essential to understand the exact needs of our residents. Careful analysis of the presurvey results revealed important observations. For example, 17 residents (89.5%) reported variable degrees of interest in IR, which was higher than we expected in IR. We knew approximately four residents who declared their interest in IR, but the survey revealed an even higher interest in basic IR procedures. This helped us to focus on the basic concepts of vascular and soft-tissue access and to include training on an US phantom, which was well received by our residents. Another example was that, in our institution, residents were more excited about hands-on training rather than additional didactic lectures. This is partly expected due to the procedural nature of IR practice; however, in other institutions where there is higher interest in didactics, a short didactic lecture may be included at the beginning of the training as some residents may benefit from additional didactic lectures.[3,10] Suggestions received from a free response text suggestion box were critical to fine-tune this course to the resident's needs, which was highly appreciated by all participating residents.

The direct costs of this training course were kept to the minimum. The US phantom costs about $200. While handmade US phantoms can be used and are probably cheaper, in our experience this US phantom was more practical, easy to set up, provided very good imaging quality, and was used repeatedly without major damage at the end of the academic year. Only one phantom, US vascular access phantom, was used in this training course. Additional phantoms, like anatomical vascular models, can be added to enhance the learning experience depending on the financial resources available at different institutions. To minimize the indirect costs of training, the training was conducted using one of the two US machines available in our IR suite, when not used for clinical service. The training was conducted during the academic time of a single specific IR attending to minimize interruption of the clinical service. While this strategy kept expenses low, it also came with challenges since the US machines may not be available at the same time when the attending is available, which explains the fact that some residents did not receive training on the US phantom. This could have been avoided if more US machines were available

or more attendings are willing, and available, to run the hands-on training. All catheters, wires, embolics, access, and closure devices included in the course were obtained from our expired inventory.

The postsurvey results were significantly in favor of the training course. As shown earlier, the overall comfort level has significantly increased following the training course, reflecting high level of satisfaction among the trainees. The inclusion of US vascular access phantom training was greatly appreciated; we received feedback to include other phantom models (e.g., biopsy model) in future courses. Since the training course addressed the basic concepts of IR practice, our junior residents appreciated the introductory nature of the training course. This explains the fact that residents would prefer to receive this basic training course in the first year of residency to be better prepared and more familiar with IR equipment when they start their first IR rotation. Interestingly, although R4s participated in the presurvey, they unanimously chose not to receive this training course. Upon interviewing R4s, reasons quoted for not participating were that the concepts discussed in the training course were far too basic for their level of training. In addition, these R4 residents had already decided on what career/fellowship they would pursue, and therefore had little interest in IR or the completion of the IR training course. While this was a bit disappointing, it highlights the importance of introducing this training course early in training when residents are excited and willing to learn new skills. In addition, this training course was designed to provide an introduction to IR and to familiarize junior residents, especially DR residents, with the essential tools and skills needed to perform basic IR procedures. Senior IR residents may benefit more from a more comprehensive training course addressing advanced IR concepts (e.g., stents, ablation techniques, inferior vena cava [IVC] filters, etc.).

Our study was not without limitations. We had a small sample size of only 25 residents, and not all of them participated in completing the survey. The study took place at a single, medium-sized academic institution over the course of one academic year. As such, the outcomes seen in our study may not be generalizable to other smaller or larger academic institutions. R4s opted not to receive this training course as discussed, so it is unclear how this course would be received by senior residents. Finally, our only outcome measurement metric was through short-term surveys. While surveys are commonly used in this context, like all survey-generated data, the presence of response bias is possible. In future studies, long-term follow-up surveys in addition to other more objective metrics can be used to evaluate residents' performance like evaluation of the time to completion of procedure and degree of attending participation during various procedures among residents who participated in the training course against those who engaged solely in a master–apprentice model of training.

Conclusion

A personalized, cost-effective, hands-on training course was designed to cover the basic concepts of IR. Our results showed that the course was well received by the residents and significantly improved their IR training experience. This model can be easily adopted in small to medium-sized academic institutions and may be modified as needed to fit the needs of radiology residents.

Conflict of Interest
None declared.

Acknowledgment
The authors would like to thank the nursing staff and technologists at our institution for the valuable assistance in providing the appropriate learning environment and resources to conduct this training course.

References

1 Khaja MS, Jo A, Sherk WM, et al. Perspective on the new IR residency selection process: 4-year experience at a large, collaborative training program. Acad Radiol 2022;29(03):469–472
2 Chapman T, Chew FS. Introductory lecture series for first-year radiology residents: implementation, investment and assessment. Acad Radiol 2013;20(03):332–337
3 Colucci PG, Gao MA, Schweitzer AD, et al. A novel hands-on approach towards teaching diagnostic radiology residents MRI scanning and physics. Acad Radiol 2023;30(05):998–1004
4 Mukund A, Bhardwaj K, Mohan C. basic interventional procedures: practice essentials. Indian J Radiol Imaging 2019;29(02): 182–189
5 Findeiss LK, Everett C, Azene E, et al. Interventional radiology workforce shortages affecting small and rural practices: a report of the SIR/ACR Joint Task Force on recruitment and retention of interventional radiologists to small and rural practices. J Am Coll Radiol 2022;19(12):1322–1335
6 Siragusa DA, Cardella JF, Hieb RA, et al; Society of Interventional Radiology. Requirements for training in interventional radiology. J Vasc Interv Radiol 2013;24(11):1609–1612
7 Nesbitt CI, Tingle SJ, Williams R, et al. Educational impact of a pulsatile human cadaver circulation model for endovascular training. Eur J Vasc Endovasc Surg 2019;58(04):602–608
8 Mirza S, Athreya S. Review of simulation training in interventional radiology. Acad Radiol 2018;25(04):529–539
9 Sekhar A, Sun MR, Siewert B. A tissue phantom model for training residents in ultrasound-guided liver biopsy. Acad Radiol 2014;21 (07):902–908
10 Minocha J, Yaghmai V, Hammond N, Pyrros AT, Nikolaidis P. Cardiac imaging training in radiology residency programs: a survey of radiology chief residents. Acad Radiol 2010;17(06): 795–798

